APR -1 1938

April 1938

TECHNOLOGY REVIEW

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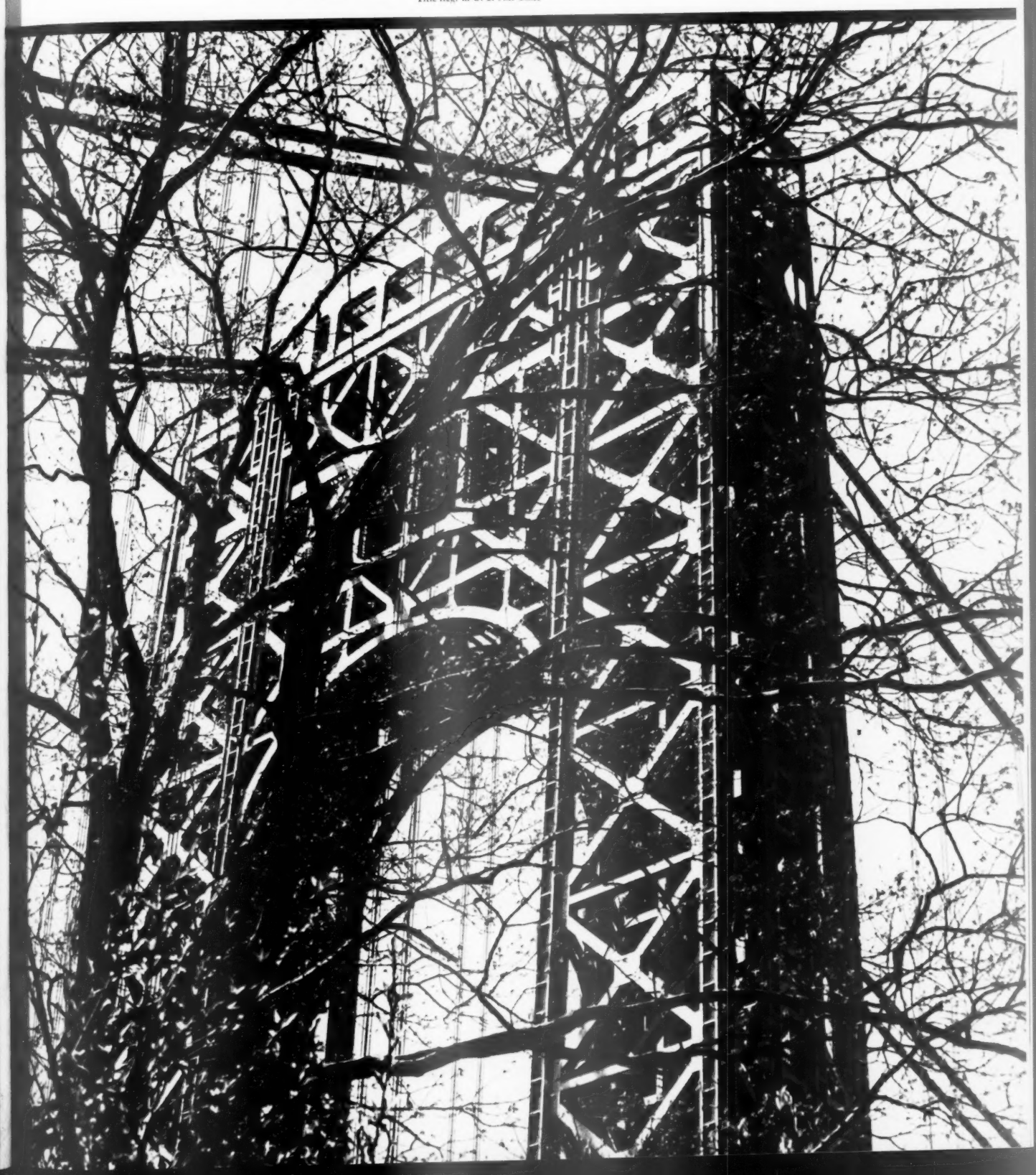

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Chesterfield's refreshing mildness... good taste... and appetizing aroma

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THE TECHNOLOGY REVIEW, April, 1938. Vol. XL, No. 6. Published monthly from November to July inclusive at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

THE TABULAR VIEW

AN officer of a midwestern university recently wrote: "I should like to take this opportunity to express my appreciation for your splendid alumni publication, The Technology Review. I never miss an issue. The excellent format and photographs are most unusual. I trust that someday you may find it possible to increase the scope of the publication to include all current progress in technology, and release it for the general public. There is a distinct need for a well-edited magazine in this field." The Review agrees that there is need in this country for a more comprehensive magazine dealing with science and technology, and it has been gradually widening its editorial scope in an effort to fulfill this need and, at the same time, to stick to its first objective of serving the Institute and its Alumni. This issue may be taken as an example of how The Review is now performing this double function. Significant, too, is the fact that 17 per cent of The Review's circulation goes to non-Technology readers. If there are other fields which readers feel The Review should cover, they are invited to make suggestions.

SINCE joining The Review Staff in 1936 Professor PHILIP M. MORSE has contributed such important articles as "The Solid Matter Mystery," "Signals From the Great Outside," "Philosophers' Stone: 1936 Model," and "Yardsticks for Infinity." In this issue (page 265) he brings us up to date on some of the recent advances in the earth sciences. ¶ MARTIN J. BUERGER, '24, is an associate professor of mineralogy and petrography at the Institute. On the MacMillan expedition to Baffin Island last summer, about which he writes in this issue (page 268), he was chief mineralogist and geologist. ¶ CECIL G. DUNN, '30, is an instructor in Technology's Department of Biology and Public Health. For a number of years he has been conducting research on disinfectants and germicides. His article on page 271 is an outgrowth of this work. ¶ Professor TENNEY L. DAVIS, '13, is a regular contributor to The Review, covering mainly the history of science and chemistry (page 273). ¶ HARRY M. GOODWIN, '90, is dean of Technology's Graduate School, and his friendship with George Ellery Hale, '90, dated back to their student days together (page 277). In 1926 Dr. Hale dedicated his book, "Beyond the Milky Way," to Dr. Goodwin.

IT has been a long time since we have had the pleasure of electing a new member to our Cover Club — the group of amateur photographers who have had photographs reproduced on The Review's cover. This month, with vernal enthusiasm the Club renews its membership solicitations and receives a new member of unmistakable gifts — GEORGE A. MAKAROFF, '26, who discovered the entirely fresh view of the George Washington Bridge shown on our jacket this issue. ¶ Are there not other amateurs bearing prints — tickets of admission to the Cover Club's arcana?

No. 6

Just for Fun!

A CHALLENGE

TO YOUR INGENUITY

HAVE you ever considered just how an electric light must be wired so that it can be switched on and off from several different places independently? The commonly used circuit for this purpose may *seem* obvious when you know it, but its design presents a fascinating problem to the uninitiated.

If you are already familiar with the standard circuit, you can get an idea of the difficulties involved by trying to design an entirely different four station circuit. (The problem can be solved.)

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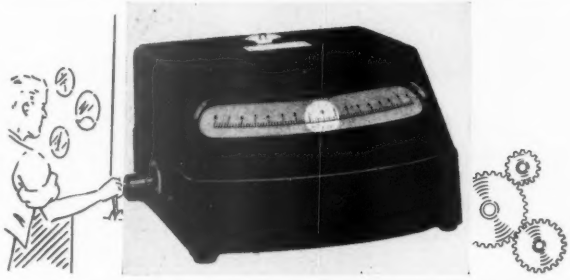

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Laboratory Accuracy... Shop Ruggedness

The Cambridge Spot Galvanometer provides a complete outfit — galvanometer, lamp and scale — in one self-contained metal case. It is robust, has a stable zero and does not require accurate levelling. The sharply defined spot can easily be read at a distance. The lamp may be operated on A.C. service current or 4-volt battery. Sensitivity in mm. on scale is from 19 to 170 per micro-ampere using coils of 10, 40 and 700 ohms. Scale can be read to 0.2 mm.

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FOR a thing so important to modern life, an electric motor is an amazingly simple device. Just a few pieces of steel and iron, wound with coils of wire. Any bright boy can follow instructions and make one that will run.

Yet the most romantic story ever told could be written about the electric motor. It runs practically every mechanical device in use today. It turns the wheels of industry — carries people to work from the suburbs to the topmost floors of tall buildings. The daily lives — even the livelihood — of most of us depend in some way upon it.

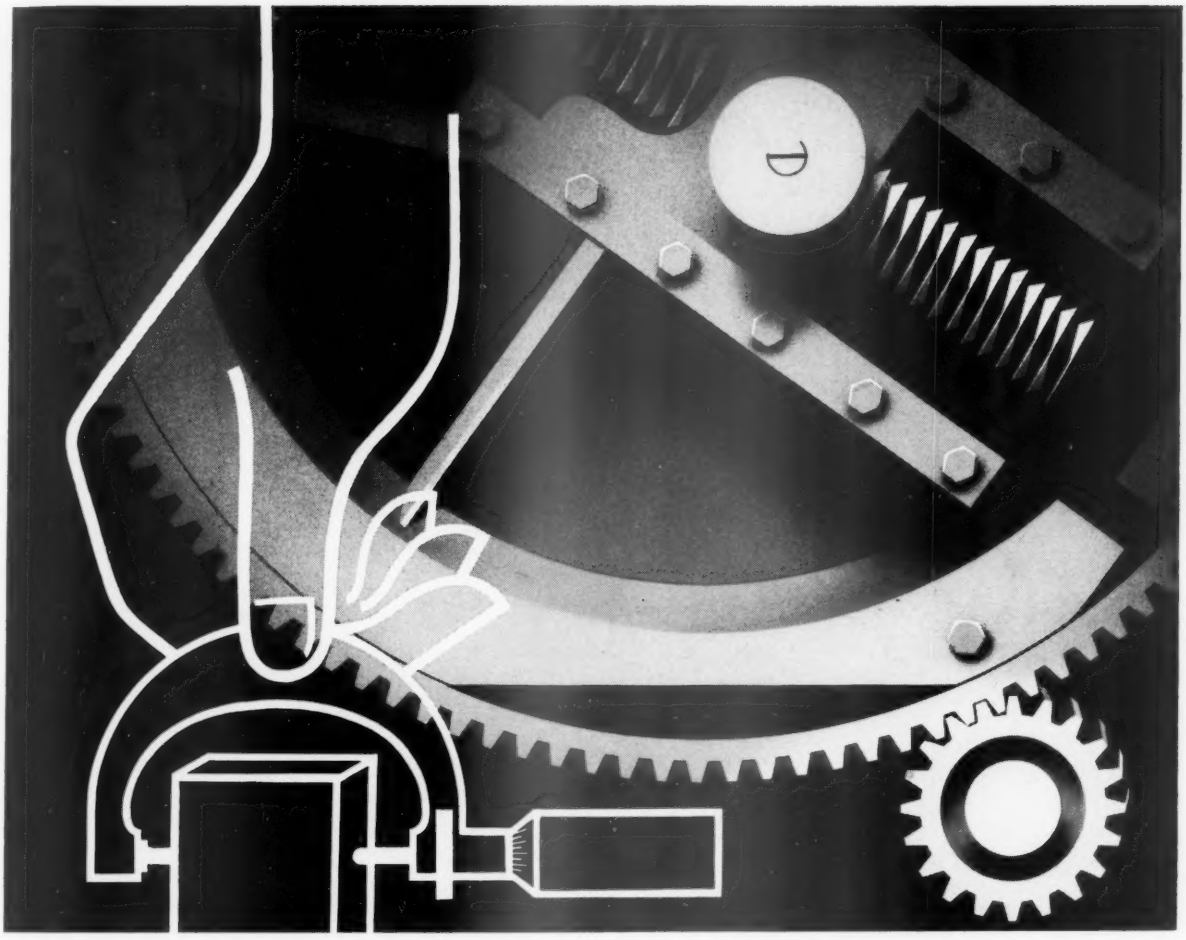
The job of fitting electric motors to the world's work is an exacting one. What makes it complicated is that every task, to be done efficiently, requires a certain kind of motor. Westinghouse, for example, offers over 20,000 different types, sizes and ratings. If none of these is exactly what is needed, a special model will be built to order.

The electric motor is "bread and butter" to Westinghouse — and to just about everyone else. Fully conscious of its responsibility, Westinghouse research continues each year to seek improvement in motor design — so that the world's work may be done better, faster, and at less cost.

Westinghouse

The name that means everything in electricity

APR -1 1938



PRECISION

IT TAKES a precise machine to turn out precise work. And if its vital parts are made of Moly irons or steels, the longer maintenance of its precision is assured. Shapers, for instance.

One company building such machines uses 0.50% Mo, Nickel-Moly iron for main and intermediary gears in the power transmission system. This iron is used because ***it possesses the wear resistance which preserves the close tolerances necessary to prevent "chattering."*** Also—because it machines readily despite its comparatively high hardness.

Thus, the use of Moly brings advantages: (a) to the builder of the machines through simpler and more economical fabrication; (b) to the user through better performance due to longer maintained precision; (c) to the user's customers through better products.

Our technical book, ***"Molybdenum in Cast Iron,"*** contains money-saving data. Free to engineers and production executives. Drop us a card and we will send it to you. Climax Molybdenum Company, 500 Fifth Avenue, New York City.

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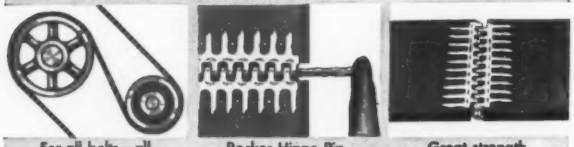

For all belts—all speeds. Flexible. | Rocker Hinge Pin. Separable joint. | Great strength. Long life.

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12 Sizes in Standard Boxes.

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MAIL RETURNS

On "Rubber and Life"

FROM ERNST A. HAUSER:

There appeared in the February issue of The Review a contribution by George W. Gray, entitled, "Rubber and Life." This article, reporting on work done by Francis F. Lucas and A. R. Kemp who simultaneously described their research in *Industrial and Engineering Chemistry*, 30:146 ff (February, 1938), calls for a few comments.

It would be foolish to deny the perfection of the microscopic technique developed by Dr. Lucas. He is recognized as a master in this field. The ultraviolet microscope, first proposed by A. Köhler and placed on the market by the Zeiss works in Jena (Germany) and later also by the Bausch and Lomb Optical Company of Rochester, N. Y., is by no means so uncommon and unsuccessful as the author makes one believe. It has been, and still is, used with complete satisfaction in many research problems, but, moreover, it is a known equipment for particle-size and shape determination of pigments.

For illustration of this fact the reader is hereby referred to the work of Henry Green: *Industrial and Engineering Chemistry*, 16:677 (1924); *Chemical and Metallurgical Engineering*, 28:53 (1923); *Journal* of the Franklin Institute, 192:637 (1921); *ibid.*, 204:713 (1927); to the work of Haslam and Hall: *ibid.*, 209:777 (1930); *Journal* of the Optical Society of America, 24:14 (1934); and to the full description of the technique in *The Activator*, 1:33 (1935). The publication last referred to contains a photograph of the setup, which demonstrates the general identity of the instruments used in both laboratories.

It may also be of interest to the general public to know that a rubber tree will yield an average of one fluid ounce of latex per tapping, *i.e.*, that 128 trees would give one gallon of this basic raw material. This should not mean that the gallon obtained for experiments originated from 128 trees only, but it might avoid some misunderstanding.

Dr. Lucas did not "add seven per cent of salt to 10 centimeters of distilled water," but used 10 cubic centimeters of a seven per cent salt solution. This addition does not influence the Brownian motion, as such, at all. Brownian movement results from millions of impacts, or bombardments, of the molecules of the liquid medium on the minute particles suspended therein. It depends only on the size of the particle, which must be sufficiently small to stay in suspension and to be pushed about. The addition of salt causes a neutralization of the electric charge of the latex particle. The latex particle is negatively charged, but the positive sodium ions of the salt neutralize this charge. Thus the particles lose their mutual repellency, cling to each other when they collide (aggregation, flocculation, coagulation), or adhere to the microscope slide, or cover glass, being held by so-called molecular attraction forces.

The particles have now completely changed their physical properties; they are defenseless captives at the mercy of any outside influence. When the cover glass is placed over them, it will distort them: They will flatten out, stick together, and so on. However, all this can have no bearing on the shape of a particle in its free-moving state. We have much more delicate means than the ultraviolet microscope to prove that even the smallest (ultramicroscopic) particles of older trees are, in the majority, nonspherical.

As to determination of particle size, the author states that the minimum size of a particle is currently taken to be half a micron. This is not true. Sufficient literature can be cited to prove that the existence of a considerable amount of much smaller (ultramicroscopic) particles has been recorded. Dr. Lucas' valuable contribution is the evaluation of particle-size distribution curves, but these are of interest only for bulk latex and have no significance for latices of individual trees.

The ultramicroscopic studies discussed and the preferential alignment in pearl strings cannot be considered as new discoveries (see f.e., V. Henri, *Comptes Rendus*, 144:432 [1907] and his contributions in Morisse's book, "Le Latex," [Paris, 1908]). Such studies are no more fundamental — in fact much less — than studies on other colloidal systems and colloidal phenomena, at least if one wants to draw any conclusions concerning the protoplasm and its constant changes.

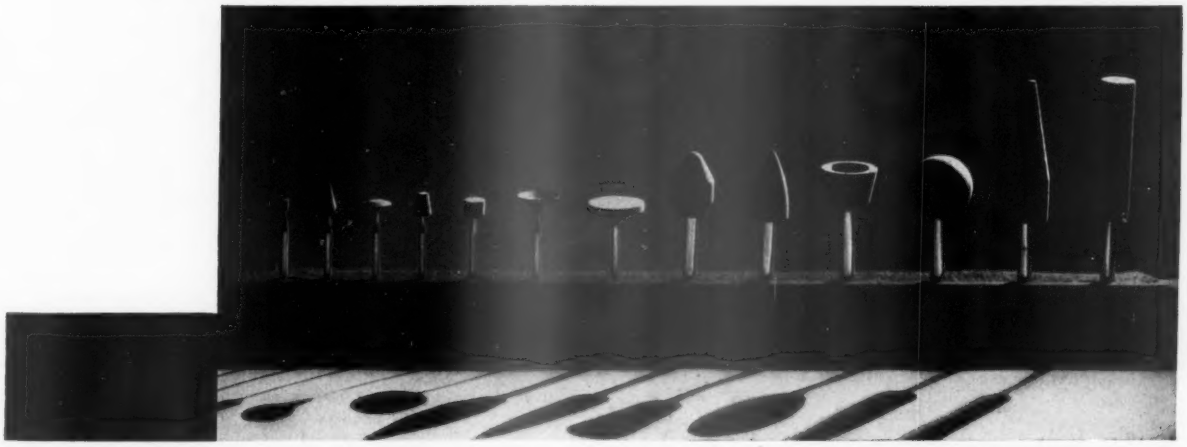
Dr. Kemp's picture of the complicated structure of the tiny latex particle is an excellent confirmation, in general, of experimental results obtained some 15 years ago by dissecting (*Concluded on page 284*)

Plastics Depend on Grinding

Norton surface grinders are used for a multitude of surfacing operations in the tool room of General Electric's new million dollar plastics plant at Pittsfield, Mass. Especially effective on the tool steel alloys used for these molds is the new Norton "B-E" bond wheel.

For the final finishing operations on molds, Norton Mounted Wheels and Points are used. They are made of fast-cutting 38 Alundum abrasive and are available in an almost unlimited number of sizes and shapes. A catalog showing the complete line will be sent on request.

NORTON COMPANY • **WORCESTER, MASS.**



The G.T.M. ANALYZED THEIR DRIVE

..now belts run *6 times longer!*

HERE is a typical example of the economies that can result from having a difficult drive correctly analyzed and properly belted by the G.T.M. — Goodyear Technical Man.

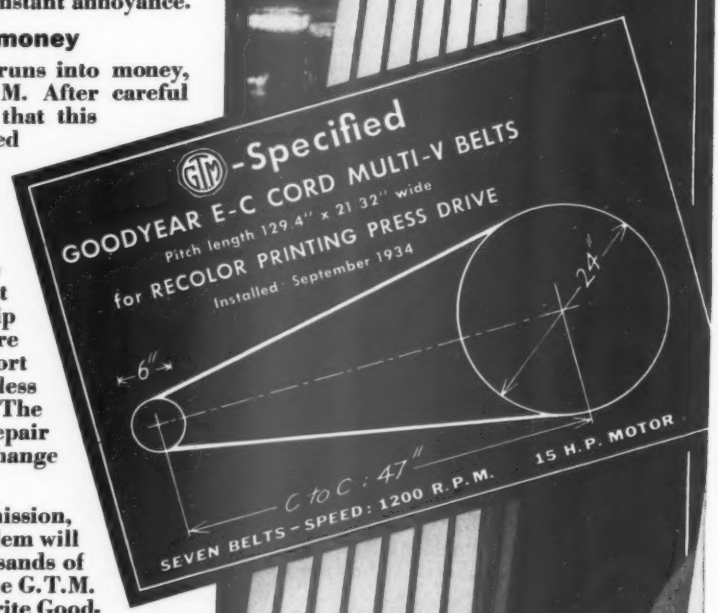
The drive in question is on the recolor printing press in a large Texas wax paper mill — operated when installed by a conventional flat belt hook-up. Under typical paper mill conditions — moisture and overload — standard grades of belting averaged only 7 months' service and slip was a constant annoyance.

Saved space—and money

A new belt every seven months runs into money, so the mill called in the G. T. M. After careful study the G. T. M. recommended that this drive be changed over to grooved pulleys for V-belt operation and in September 1934 a set of seven matched Goodyear B-128 E-C Cord Multi-V Belts was applied.

Today, 43 months later, this entire set of belts is still in operation. Not a single belt has been replaced, slip has disappeared, the press runs more evenly than ever before and the short center V-belt drive takes up much less valuable space around the press. The elimination of replacement and repair expense has repaid the cost of the change many times over.

G.T.M.-analysis of your transmission, conveyor or elevator belting problem will pay you similar dividends as thousands of records like this prove. To bring the G.T.M. to your office for a friendly talk, write Goodyear, Akron, Ohio, or Los Angeles, California — or phone the nearest Goodyear Mechanical Rubber Goods Distributor.



THE GREATEST NAME IN RUBBER

GOODYEAR

MULTI-V E C CORD BELTS

BELTS
MOLDED GOODS
HOSE
PACKING
Made by the makers of Goodyear Tires

APR -1 1938

Martin J. Buerger, '24

THIS IS A SUNDOG

. . . an arctic display caused by refraction of sunlight by ice crystals in the atmosphere. The sun is out of the picture to the left. Other names for the phenomenon are mock sun or parhelion. This photograph was taken in Frobisher Bay, described on page 268 ff.

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VOL. 40, NO. 6 CONTENTS APRIL, 1938

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From a photograph by George A. Makaroff, '26

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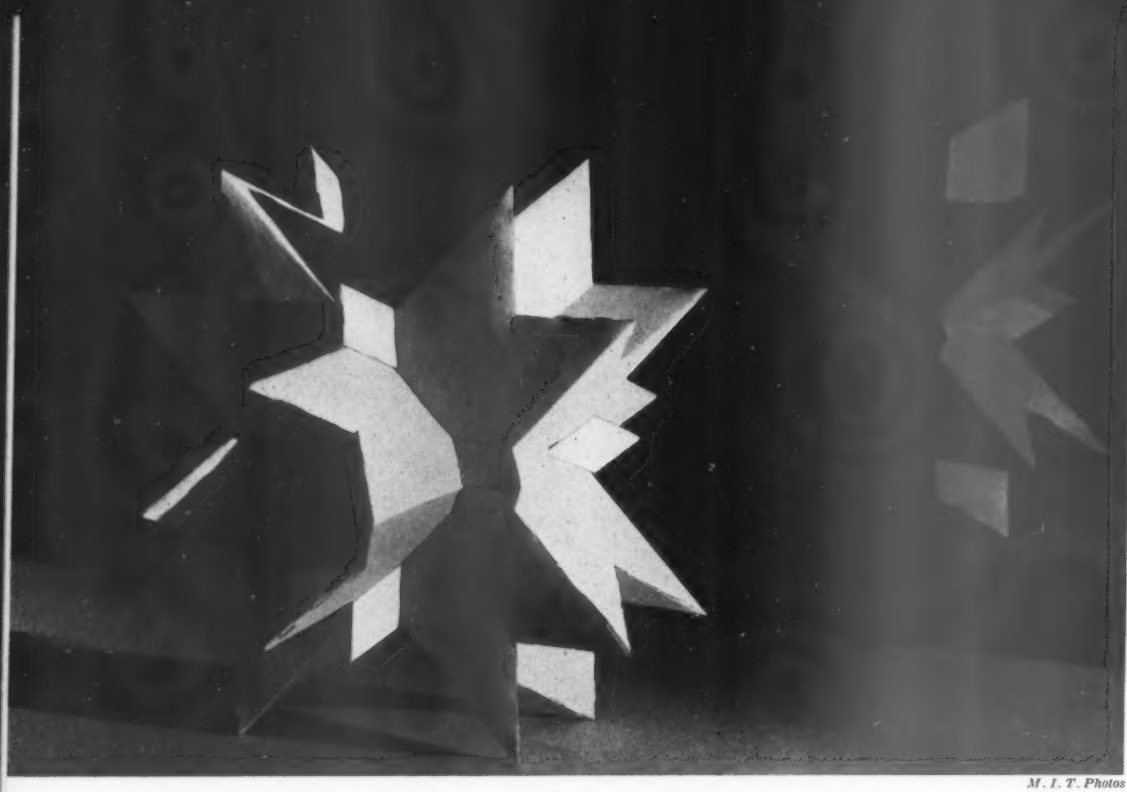


Left. THE CHARMING MODEL IN THE FOREGROUND STRUTS THE DELIGHTFUL NAME, "TETRAKAIDECAHEDRON, FOURTH SPECIES," BUT NEVERTHELESS IT IS A HARMLESS LITTLE SOLID THAT PLAYS ENGAGINGLY WITH SHADES AND SHADOWS.

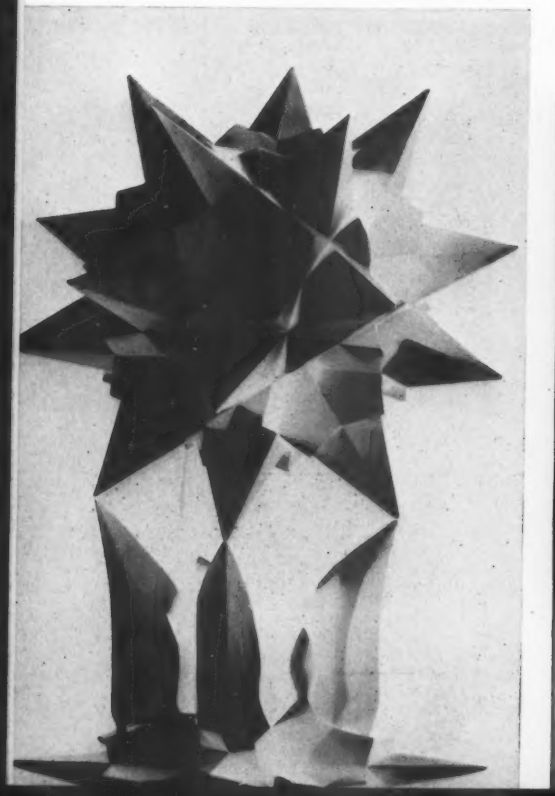
THE MODELS ARE MADE WITHOUT ADHESIVE BY AN INGENIOUS SYSTEM DEVELOPED BY MR. WHEELER OVER 20 YEARS AGO. A SELECTION OF HIS MODELS IS NOW ON EXHIBIT AT M.I.T.

M. I. T. Photos

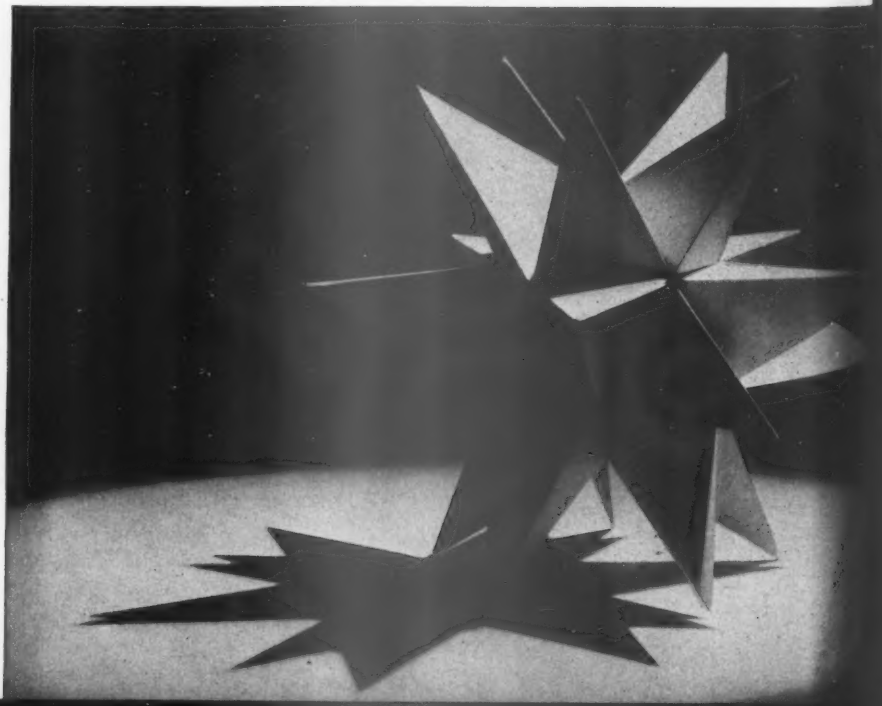
Exploring Space with Scissors and Paper

HE opens a notebook and out pops a mathematical model. He pulls a disassembled one out of his pocket and challenges you to turn it into a full-blown model. He teaches mathematics in North High School in Worcester, Mass., and his young students find themselves having fun and gaining insight into the complexities of solid geometry by making paper models of such solids as rhombic trapezoidal dodecahedrons (*opposite page, left*) and icosahedrons (*opposite page, right*). His name is A. Harry Wheeler, and his hobby of "paper engineering," samples of which are shown adjacently, has prompted requests for exhibits from colleges and mathematical societies and supplied him with a teaching tool that helps flat young minds to expand into the third dimension and to perceive the beauties of geometrical form.

INSTRUCTOR WHEELER, A FEW OF HIS MANY HUNDREDS OF MODELS, AND A RAPT STUDENT WHO HAS FOUND THROUGH BOTH THAT MATHEMATICS, HOWEVER RIGOROUS, MAY BE FASCINATING



Left. ICOSAHEDRON
Below. A PENTAGONAL DODECAHEDRON



THE
TECHNOLOGY REVIEW

Vol. 40, No. 6 April, 1938

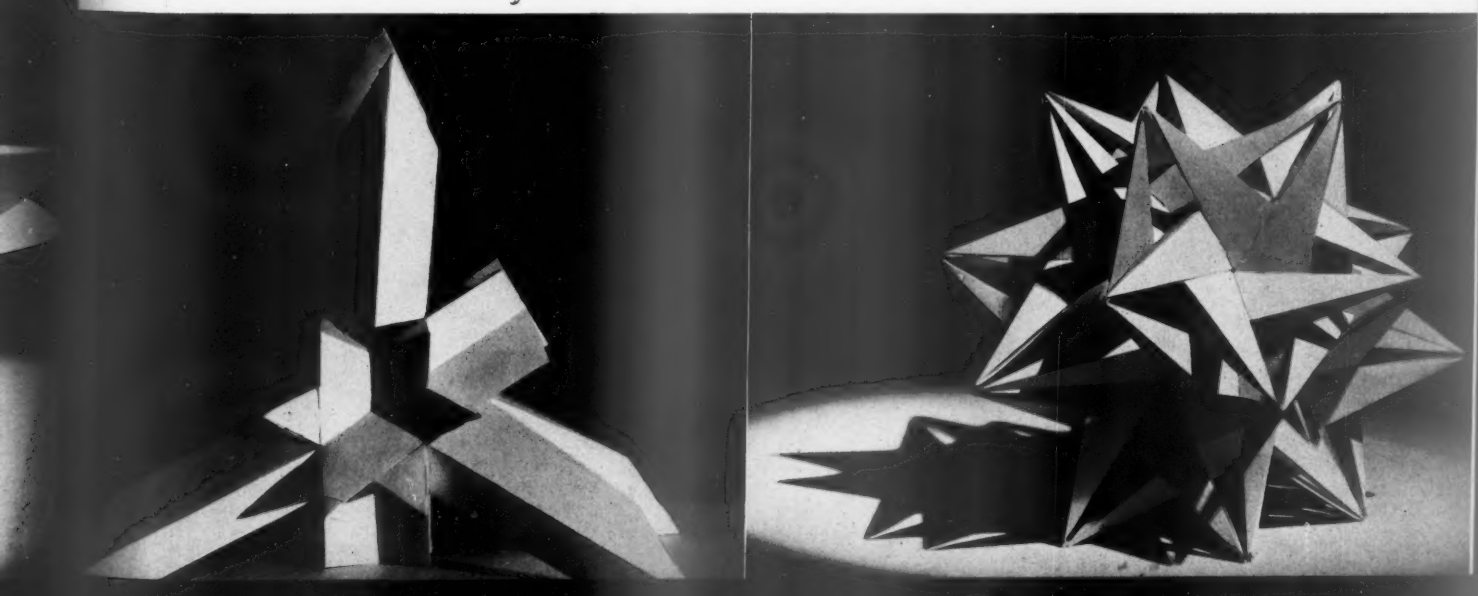
The Trend of Affairs

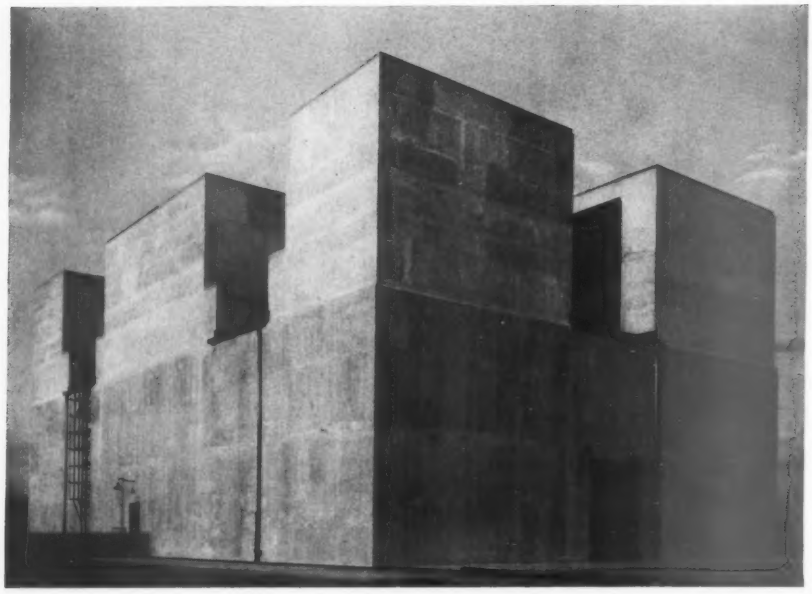
Footnotes to Our Life Expectancy Table

MAN'S paradoxical nature is neatly illustrated in the fact that as he improves his chances for long life, equally does he increase his ability to shorten life either through accident or through design. And all the time, among his greatest interests are the questions not only of how he may increase the length of his stay in this vale of tears but also of how he may predict his chances.

Indication of a partial answer to the first question sometime in the future is contained in reports from Brown University investigators who have nearly doubled the life span of water fleas through regulated feeding. If the water flea is given a limited food supply when young and a normal diet after maturity, its vigor, growth, and reproductive life are increased from the normal span of 29 days to from 42 to 51 days. Corroboration for the popular belief in the desirability of a frugal, even Spartan, youth for mankind may be had from these experiments, according to Professor Arthur M. Banta, who said that the results of these studies may possibly point the way to longer life for man. "Persons who lead very frugal lives until past middle age, and then have generous living, may be expected to live longest," he said. Associated with him in the study are Dr. Lester Ingle and Howard Dunham.

The second question — that of anticipating the bad news — has also received partial answer lately: Dr. Raymond Pearl of Johns Hopkins announced that study of the relation of biological constitution to human longevity makes possible the classification of long-lived and short-lived among people who will die of diseases of the heart or blood vessels. Medical, anthropometric, and genetic constitutional examinations, made when the persons are in a state of health, make differentiation possible long before the onset of the diseases which will ultimately be fatal, he said. Other results of Dr. Pearl's study, slightly dismaying to the Epicurean element, are his statements that "smoking is associated with a definite impairment of longevity," which even with moderate smokers is sufficient to be measurable and significant; that moderate use of alcoholic beverages gives no measurable effect on longevity, though heavy



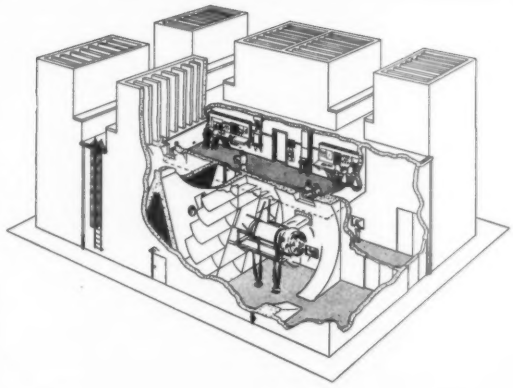


POWER PALACE

Four airplane engines of up to 3,000 horsepower each, can be accommodated in this spectacular new test house built by Pratt and Whitney Aircraft in East Hartford, Conn.

The test chambers, one of which is shown below, are large enough to swing the great 23-foot propellers required by 3,000-horsepower engines.

To reduce noise, a new type of sound-absorbing acoustic material, known as Calistone, is suspended in parallel rows within the intake and exhaust stacks



indulgence "definitely and considerably impairs life expectation"; and that hard physical labor, whether indoors or outdoors, has no effect on expectation up to about 40 years, after which it results in definite impairment.

On the Record and Off Again

MUSIC lovers who satisfy their urge with phonograph records have complained, without much effect, of the short life of commercial pressings. A full symphony of ten records represents a considerable investment, but after five playings the first flower of the tone quality is gone, and after 25 playings the needle hiss increases in prominence. One hundred performances are sufficient to depreciate the investment completely. In the popular-music field, short life is not serious, since rapidly moving fashion renders most records obsolete before they are played 50 times. But classical records could remain a joy — if not forever, at least for a good many years — were it not for the wear and tear to which they are subjected by the reproducing equipment.

The principal cause of wear is the high pressure with which the needle point bears on the bottom and sides of the record groove. The weight of the reproducer ordinarily is from two to three ounces. When this force is transmitted to the record through the sharp point of the needle, the pressure on the record itself is many tons per square inch, so close to the elastic limit of the plastic record material that serious wear occurs in a very short time. The answer to the problem has been obvious for some time: Reduce the weight of the reproducer assembly. But if the weight is reduced, the needle will not track properly in the groove. Faithful tracking at reduced pressure is possible only when the needle suspension is very delicately balanced. And delicate balance makes an expensive and fragile instrument.

Now comes word that two members of the research staff of Cruft Laboratory at Harvard — F. V. Hunt and J. A. Pierce — have developed a suspension which is delicate, electrically and acoustically, but sturdy mechanically. The needle itself is a finely shaped sapphire and requires no replacement. It is mounted at the apex of a small cone of aluminum, through the sides of which two thin phosphor

bronze strips pass. These strips are attached to the arm of the reproducer assembly in such way that they pass through uniform magnetic fields of opposite polarity supplied by permanent magnets attached to the end of the arm. When the sapphire needle is moved sidewise in its passage along the groove on the record, one bronze strip moves down through the magnetic field while the other moves up. Consequently an electric current whose strength is proportional to the amplitude of the needle motion is magnetically induced in the strips. This current is extremely small, but its strength can readily be increased by vacuum tube amplification. In fact the new reproducer has about the same power output as a high-quality, broadcast-station type microphone and can be amplified by the same equipment. The conventional reproducer obtains a much higher voltage output, necessitating less amplification, but at the expense of a massive and stiffly mounted needle suspension. By throwing away power output, readily made up by amplification, Hunt and Pierce have gained an extremely lightweight suspension. The results: perfect tracking at five grams (0.17 ounce), and one hundred playings of commercial records without any observable wear.

The reproducer was developed primarily for the valuable records made during the Harvard Tercentenary Celebration. When its electrical characteristics were tested, to everyone's surprise they were found to be as much of an improvement as were the mechanical ones. The instrument was found capable of reproducing any note from four octaves below middle C to six octaves above middle C, without discrimination (in technical parlance, frequency response variation less than three decibels from 30 to 18,000 cycles per second). The upper extremes of this vast range have little value except in reproducing the highest upper partials (overtones) of such instruments as the tambourin. The reproducer is in fact capable of handling more quality than can at present be put on a record; so it will be valuable not only for preserving present-day records, but for the improved records of the future.

Squealing for Profit

TO the standard method of liquefying the almost ideal gases — which consists essentially of compressing the gas, cooling it to a convenient temperature, and then allowing a sudden expansion to cause a further drop in temperature — has been added a whistle.

The squeal, placed in the expansion valve by Chester W. Rice of the General Electric Company, converts some of the heat energy into sound energy, and thus causes a somewhat greater fall in temperature than would otherwise be the case. Conversion of heat into sound energy is greatest at a definite pitch, and, as would be expected, the sound must be allowed to escape easily from the liquefying chamber in order to achieve maximum efficiency.

The Myth of the Bursting Wall

BEGINNING perhaps three years ago, vague and disquieting rumors began to be heard in the building industry. According to unsubstantiated reports, there had been some fearsome goings on during this and that winter in this and that cold spot. Old barns in Canada which had stood their ground stanchly through the centuries needed only, it appeared, to have their wall spaces stuffed with insulation in order to burst their seams. One worried house owner, the stories went on to tell, had spent one Sunday excavating near the sill of his house and had come up with a solid chunk of mineral wool and ice.

Largely associated as these tales were with insulations of the fill type and no doubt given a push here and there by ambitious salesmen for other types of insulation, these rumors soon flew from the mouths of those who had a professional interest in their truth to the

Cushing

ACCENT ON FUNCTIONALISM

In Albany, N.Y., stands this mammoth and handsome grain elevator

consuming public. As a result of all this talk, the house owner of this spring is quite acutely conscious of condensation — a phenomenon which has not bothered him before. Professionals have been worried about it longer. As early as last October the Forest Products Laboratory published a preliminary report on the matter and, even before that, a joint project of the University of Minnesota and the National Rock Wool and Slag Wool Association, under the guidance of Professor Frank B. Rowley, had begun to study the same problem. The Rowley report, recently off the press, though somewhat more scientific in its terminology and though based on a different type of study, confirms in every essential detail the earlier report of L. V. Teesdale, senior engineer of the Forest Products organization.

Neither pays any attention to the mythical bursting barn, though it is clear that both think that under sufficiently strenuous conditions such a debacle might have taken place. Both are at some pains to make clear that trouble with water in wall or roof spaces is not unique to fill types of insulation. Both have the same conception of the cure. Both are reassuring, except to the quizzical, when they point out in almost identical words that "the problem is not to be feared after it is once understood."

Condensation itself is, of course, no new thing. It might have been found at any time in a cold climate in any building whose interior was at reasonably high humidities. The cases in which it occurred in days past were sufficiently rare so that engineering might accept it as a necessary evil and exercise special precautions for drainage or other elimination. Condensation, as surely every reader of The Review will recall, is the sort of thing which happens on the ice pitcher on a humid day in the summer. It is caused by water vapor coming in contact with a surface, the temperature of which is below the dew point for the water vapor in question. When that happens on an ice pitcher, we get drops of water. When it happens on the inside surface of sheathing, we get similar drops of water, although we do not see them. If the sheathing is below freezing temperature, ice may actually be formed. Even if it is not and even if we do not see the water which is being deposited, that water may do damage to the frame, the boarding, or even to the insulation. It is just as well not to have it.

Ellis O. Hinsey

Korth

UNLOADING

. . . iron ore boats at the Gary works of the Carnegie-Illinois Steel Corporation

Three almost simultaneous developments in house-building technique have now made the problem one which faces every builder. In the first place, weather stripping and other methods of making the building tighter have also tended to build up the difference in vapor pressure between the inside and the outside of the house. This makes the water vapor more anxious to escape through the wall diaphragms. Secondly, there has been an unquestioned tendency actually to increase the humidity, and therefore the vapor pressure, in the house by artificial means. A considerable battle is being waged at this very moment as to what degree of humidity is desirable. Whatever physiologists ultimately decide, we still have the increase today. Finally, the increased use of insulation has made warmer that part of the wall which is inside the insulation but, conversely, has made colder that part of the wall outside the insulation. This has had the effect of actually moving the dew point for any given vapor pressure closer to the inside of the house; with any real degree of insulation and with cold weather outside, the dew point will generally be well inside the sheathing.

Baker

HANDLING

. . . huge redwood logs such as this is now simplified by a "cruiser," shown above

Now, if the vapor pressure of the inside seeking to get out can penetrate to that layer of the wall which is at dew point, precipitation will occur. Unfortunately, all too often it can. Plaster, for example, which is an excellent barrier to air infiltration, might almost as well not be there as far as stopping vapor movement is concerned. For vapor movement is independent of air movement. Consequently, there have been many instances where vapor has pushed through the plaster, through the lath, through the insulation (few insulators except perhaps aluminum foil are much good at stopping the passage of vapor) and, coming smack against that layer of air or siding or what not which is at dew point, has condensed. Then there has been trouble.

So it is entirely possible, if you own an old house and have had its walls filled with insulation and have weather-stripped your doors and windows, that the little droplets of water are holding a *Walpurgisnacht* against your siding. About the only resolution possible to such a dilemma is to bore holes in the outside wall to relieve the vapor pressure. Experiments have indicated the validity of this idea. If you saturate the insulation in an electric refrigerator, thoroughly seal the outside, but let the wet insulation breathe to the inside, you can desiccate the insulation in no time. In a house the same thing is true in reverse. As a matter of fact, recent reliable installations on old houses have provided these ventilation holes.

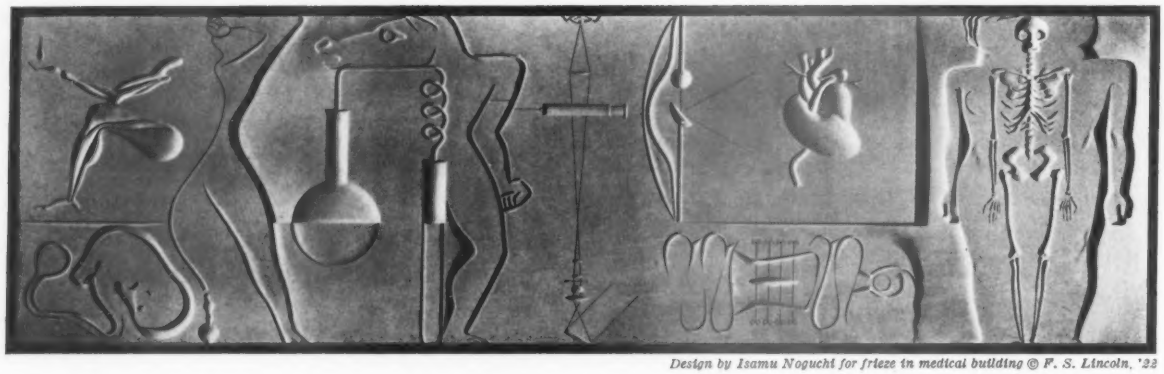
If, on the other hand, you are building a new house, the problem is much simpler. Now all you have to do is to provide a vapor seal on the warm side of the insulation. A convenient place is right back of the lath. A good many materials have been investigated as weather seals. Common ones which seem to work very well include asphalt-impregnated and surface-coated sheathing paper, glossy surfaced; laminated sheathing paper of two or more sheets of kraft cemented together with asphalt; or double-faced reflective insulation mounted on paper. A good deal more study needs to be done in this field.

The weight of evidence indicates that this vapor seal, though it should be applied with considerable care, need not be 100 per cent perfect. This, as any practical builder will realize, is fortunate indeed, particularly in regions where platform construction is unpopular.

Since fill types of insulation were the target of most of the early attacks, this much ought to be said in their defense: There is no evidence whatsoever that many of them are hygroscopic or like to stay wet. They do not resist the passage of water vapor, but no more do other types. Since they fill the whole space, the dew-point plane may occur within them and the condensation may appear within them and their surfaces may appear wet. But equally guilty types which do not reach to the siding may not by wetness betray their culpability at all. In any event it does seem that the problem is within a stone's throw of complete solution.

But in a very few years the eager selling efforts of three quite different businesses have produced the topsy-turvy results for the house that we bore holes in the outside and put the building paper on the inside. Technological developments in equipment and in comfort will undoubtedly create even more revolutionary changes in technological needs before long. This is all very discouraging for the descendant of the pioneer who built his own house, but it is strong evidence, if any were needed, that we cannot safely tolerate much

Korth



Design by Isamu Noguchi for frieze in medical building © F. S. Lincoln, '32

longer the slipshod practice by which anyone who wants to put up a sign becomes a builder. If the makers of insulation, of weather stripping, and of air conditioning are capable of a scientific nap, what shall we say of the term of sleep of the fly-by-night in the building business?

British Weather Sets a Precedent

ACCORDING to a recent analysis of observations made during the years 1815 to 1934 at the Radcliffe Observatory, Oxford, the English climate, never notorious for its inclemency, has lately been unprecedently mild. Not content with equaling in mean annual temperature the two other warm spells recorded in the 120-year period, the last 40 years have been remarkable for warmer winters and, until the last few years, for decidedly cooler summers than have previously fallen to the lot of Englishmen. As far as the two decades ending in 1934 are concerned, no other 20-year period can show a smaller difference between mean summer and mean winter temperatures. It looks as if, at least for that happy island, nature has adopted air conditioning.

Half-Tone Electrons

THE engineers engaged in television research have labored long to produce an electronic "camera" tube which would transform moving optical images into a succession of electrical impulses. Last year their efforts produced tubes of such sensitivity that they can excel the human eye. The cameras employed in televising the British coronation were of this type. Since the photosensitive surfaces in the tubes are sensitive to infrared light, the camera can penetrate fog better than the eye, a fact of great convenience on the day of the coronation. In fact, because of the ability of the camera to penetrate mist, the viewers at television receivers had a better view of the proceedings than did the engineer, himself, who operated the television camera.

But these camera tubes are expensive, and the images they produce are variable in shading and contrast; so they were considered unsuitable for the prosaic but highly necessary job of testing television receivers at the factory before shipment. A new "picture" tube has been developed, one whose abilities are very restricted compared with the camera tube, but which nevertheless is ideally suited to testing purposes. The picture tube has a very limited repertoire: It produces a fixed image — one which does not move and which cannot change from day to day.

The manner in which this image is produced is a very ingenious combination of the printing and electronic arts. Inside the tube is a flat plate of aluminum, on which has been printed, with an ordinary half-tone engraving, a reproduction of the scene or image desired. Inks for printing on aluminum have been developed at the instigation of candy-wrapper manufacturers, but the ink engineers had little idea of the use to which their new product might be put. It so happens that the secondary-electron ratio of the ink is considerably lower than the secondary-electron ratio of the aluminum on which it is printed. By this is meant that if electrons from some external source are sprayed on the plate, they will liberate other electrons from it, but the number liberated from the printed portions will be less than that liberated from the unprinted portions. Consequently, the density of the liberated electrons, as they move away from the plate, reproduces the

PHOTOGRAPHIC DRAPERIES

The photomural has won a place in decoration; now comes the photofabric, striking examples of which are shown adjacently.

Mrs. Leize Rose of New York uses this patented technique for reproducing any photographic subject on a variety of fabrics. She has executed huge patterns from six to 14 feet in length, and she has made small designs with repeated motifs. The designs are in soft monotone pastel shades or in deep colors. Here, indeed, is a new and flexible medium for the interior decorator

image printed on the plate. By collecting the liberated electrons in the proper sequence and conducting them to an electrical circuit outside the tube, an electrical signal, a counterpart of the optical image in the tube, is produced. Moreover the electrical signal is very "crisp," that is, it contains considerably more detailed information than that produced by a camera tube. Such a half-tone signal, produced in an inexpensive tube, having unvarying brilliance, contrast, and size, and having a fixed outline with which the factory inspector can soon become familiar, is obviously well suited to test purposes. When television receiver production gets under way, it is certain that many of the new picture tubes will be employed on assembly lines and in test booths to assure uniform quality.

CANTILEVERED
. . . steps, as used in this modern English house, are a pleasant though expensive tour de force

F. S. Lincoln, '22

Haldane on War

THE discussion of how science can affect warfare in the future is usually in the hands of journalists who are bathed in ignorance, in lurid color, or in both. A judicious estimate of the trends which will probably shape future weapons is therefore a refreshing change and was recently offered before a military audience by Professor J. B. S. Haldane, already renowned for his brilliant expositions on science, not so well known for his services in the "very comfortable" trenches of Flanders.

Speaking with the authority of one who can write Captain before his name and F.R.S. (Fellow of the Royal Society) after it, Professor Haldane makes some very sensible suggestions on the military value of "grossly high-brow people," points out some technical difficulties facing gas and bacteriological warfare, and indulges in a little philosophy concerning the military mind. Admitting that the conservatism of the usual officer is probably a necessity of his profession, Haldane nevertheless pleads for a more liberal attitude toward the knowledge that science is accumulating in fields whose relations to war are obscured only by Napoleon's failure to mention them.

Starting with the indisputable fact that the men who win battles are those who escape wounds and resist fatigue a trifle longer than the corresponding units on the opposing side, he arrives at the somewhat unexpected conclusion that the lord high holders of the purse strings might very well divert some of the funds now being used for the improvement of gases and explosives — which for good scientific reasons probably cannot be improved much further — into an intensive study of the physiology and psychology of fatigue.

A specific problem is the determination of the fatigue elements affecting such key men as tank and truck drivers. That special conditions exist was demonstrated during the recent strike of bus drivers in London, when one complaint of the strikers was the high incidence of stomach trouble in their trade. It may be added that industry has not only recognized for long that fatigue is closely associated with productive efficiency but has also done some very drastic things about it.

Obviously, such problems cannot be solved on short notice; neither can one reasonably expect that in time of emergency some neglected genius will instantly apply a similarly neglected scientific principle to a startlingly new method of attack or defense. Haldane states that from five years to two

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generations elapse between the discovery of a really new scientific law and its practical application to industry or war. Data in the report of the President's Committee on Technological Trends indicate an even longer lapse in the case of really fundamental inventions. Nevertheless, the possibility of military surprises in a future conflict is not ruled out, and there remain enough dreadful possibilities in techniques already being explored to create an acute need for a staff capable of tackling the unexpected. In such situations, feels Haldane, it is the academic laboratory man — the scientist rather than the technician — who makes the better showing. As the British Admiralty found out during the War, it was the grossly high-brow people, the kind who did acrostics and forgot to wear their ties, who were the only ones capable of deciphering the German naval code.

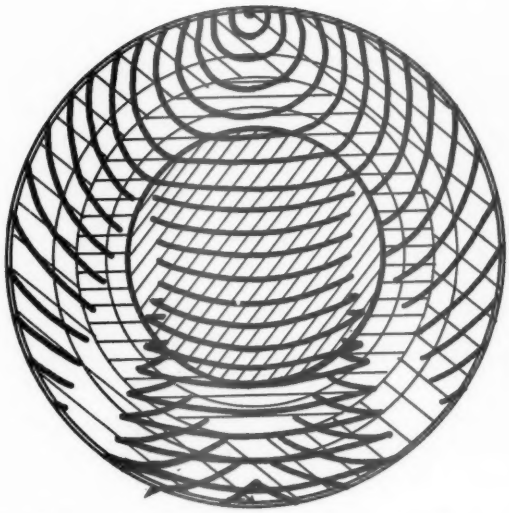
Haldane does not particularly fear innovations in the fields of high explosives and poison gases. From theoretical considerations, it is known that present powders already contain close to the maximum amount of energy which can be crammed into a given mass. Similar reasoning gives only an outside chance to the discovery of poison gases more dangerous than present ones.

The use of living poisons, however, is another matter. However solemnly abjured by civilized nations, the only likely obstacle to the use of viruses and microörganisms in warfare will be the difficulty in dispersing them alive and in such manner that enemies and allies are not promiscuously attacked. It will be simpler, incidently, to drop plant pests far behind enemy lines and permit them to "bore from within" according to the best tenets of the Marxians. It would be relatively easy, for example, to drop the potato beetle into England. More disturbing to Englishmen is the suggestion that if the yellow fever mosquito ever established itself in India, the disease would become epidemic throughout the country.

If such speculations become realities, the creation of defense techniques will be no job for generals. It will be of national importance that the right expert be given the right job, and Haldane suggests that the military masterminds keep in constant touch with the scientific personnel of the country so that they know at all times just what abilities are available.

Finally, Haldane would like to see better established the principle that no trained man be put in a nonspecialized post. He points to the brilliant physicist, Mosely, who joined the Sappers and got a bullet through his head at Gallipoli, and to himself, who served as an infantry officer but on his own admission made a better teacher of bombing. A trained man, if for no reason other than that he has a disciplined mind and good habits of observation, makes better material for training in some other specialized field than the green recruit.

While Haldane's remarks were addressed to British officers, they apply equally well to any army. His theme seems basically this: Since there is no possibility of divorcing science from war, the union might be made as effective as possible.



PORTRAIT OF AN EARTHQUAKE

If, during an earthquake, the world were sliced open like a grapefruit and the quake waves captured on the sliced surface, here is the pretty and revealing pattern they might make.

The wave fronts for the P, or push, waves are shown starting from an earthquake at the top, traveling in part through the denser core, and partially focusing at the bottom. Note the ring of shadow cast by the edge of the core. The distance, if you are interested, between successive wave fronts corresponds to one minute of travel.

On the next page is shown the seismograms from which are deduced the ideas about the earth's interior suggested by this sketch

This Ball of Clay—How Old?

Listening to the Earth's Interior. Is It Made of Iron, Green Cheese, or Cold Molasses?

By Philip M. Morse

How the Ear and Not the Eye Is Revealing the Structure of the Earth and How Nature's Most Perfect Timepiece Is Pinning Down the Old Lady's Age

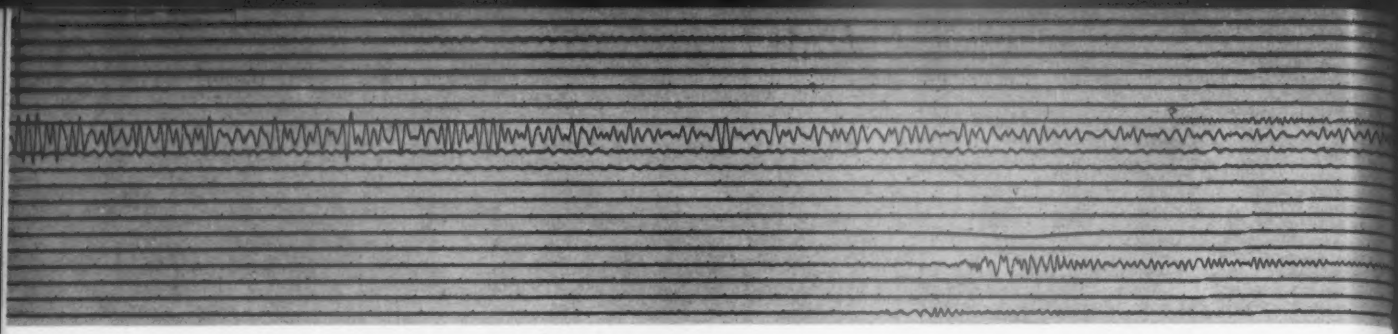
We have nearly as much trouble finding out about the earth as we do in finding out about near-by solar systems. We of course know a little about the skin of rock, film of water, and litter of life on the earth's surface — constituting about one-tenth of one per cent of the earth's volume. But we know very little about the real earth, the mile after mile of unknown material beneath our feet. The stars we can see but cannot touch; the earth's interior we can hear and sometimes feel, but cannot see. The latter handicap is, perhaps, the greater.

If the earth were reduced to the size of a grapefruit, the atmosphere would be a hazy film, a few thousandths of an inch thick; the oceans would be a still thinner film of moisture; and the thickness of the layer of rock about which we know anything directly, would be less than a thousandth of an inch. When we know only the taste of a bit of the outer, shiny surface of a grapefruit, we can hardly claim to know much about the grapefruit.

The most striking fact about our grapefruit-earth is its extreme smoothness and regularity: It is much smoother and more regular than an actual grapefruit. True, if we were to run our fingers over it, we would feel a few dents beneath the oceans and a few rough spots on the continents; but the maximum depth of the dents and height of the bumps would be less than a hundredth of an inch. Most of the surface would be as smooth as if the ball had been turned, ground, and polished. It is the skin of wax, so to speak, with which we are acquainted. Only in the last score of years have geophysicists devised instruments which enable them to do more than guess about the nature of the earth under its skin.

Measurements of the over-all shape of the earth are best made by measuring the pull of gravity at various spots. This pull is usually measured by timing the oscillation of a pendulum, and the result tells us how far the pendulum is from the center of the earth. Any local deviation of the underlying density of rock will alter the result somewhat, but this can usually be corrected for. As a matter of fact, in recent years, measurements of the pull of the earth have been used chiefly to determine these local deviations, as an aid in prospecting for oil and minerals. Oil companies have developed portable instruments which, it is claimed, measure gravity with a precision of one part in 100,000,000. This will presumably measure relative distances to the earth's center with an accuracy of less than one foot. These instruments someday will be used to make a complete survey of the earth's surface.

The fragmentary gravitational surveys made to date, with less accurate instruments, indicate that the earth is a slightly flattened spheroid, bulged around the equator. Within the accuracy of the measurements, they tell us that the earth has the same shape a liquid sphere would have if it were in equilibrium between its own gravitational pull and the centrifugal push of its own rotation. This is a very interesting result, for other measurements, a few of which we shall mention later, also seem to indicate that the greater part of the earth acts to some extent like a liquid.



SIGNATURE OF AN EARTHQUAKE

The M.I.T. seismograph in Maine made this record of an earthquake off the Californian coast. The quake record starts directly above this caption with the faint push waves coming

This is not to say that if we could drill a hole down a few hundred miles, the interior would squirt out at us as an oil well does. It simply means that if forces act on the earth for a few thousand years, the earth will yield to them, more like tar or cold molasses than like water. If a cube of rock, 50 miles on each edge, were placed on the earth's surface, within a few hundred thousand years it would have sunk into the surface to approximately the depth given by the law of hydrostatic balance. If the rock were lighter than the earth beneath, it would come to rest with its top above the surrounding country; if it were the same average density, it would sink until its top would be approximately on a level with the rest. Many geologists are convinced that mountainous regions are simply places where the light crust is somewhat thicker than usual, making this part bob above the surface, like a cork in cold molasses. Analysis of gravitational surveys near mountains seems to corroborate this theory. However, there are many exceptions and differences of opinion on the matter, which will not be settled until a complete gravitational survey is made.

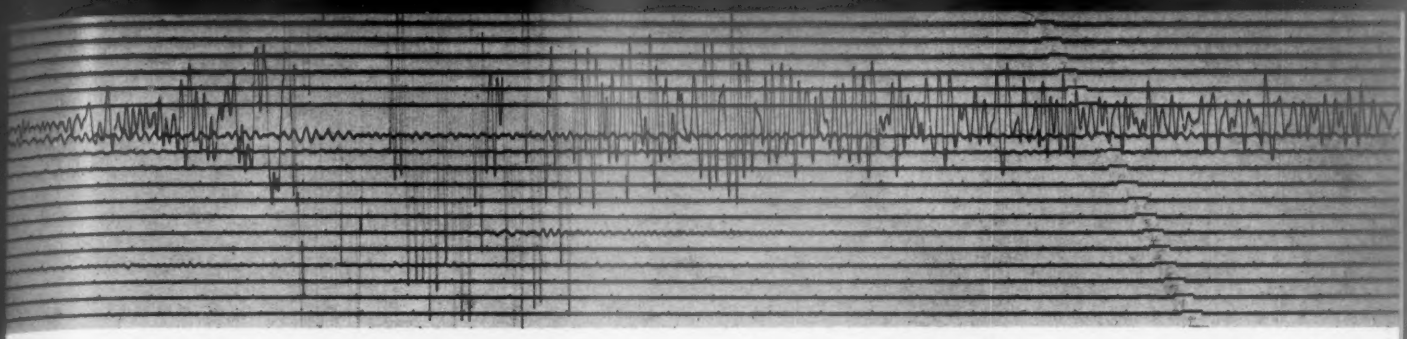
We are sure that the underlying material is heavier than the surface granite because we have weighed the earth, comparing its pull of gravity with that of a lead ball of known mass, and have found its density to be about twice as great as that of the surface material. Part of this increase of density can be explained by the crushing effect of the immense pressures in the interior, but this does not seem to be enough. The usual opinion is that there is an inner core, about the relative size of the seed in an avocado, of density about ten times that of water, perhaps consisting of a mixture of iron, nickel, and other metals.

Support for this picture comes from the science of seismology, which is a technique for diagnosing the earth's structure by listening to its internal rumblings — a standard medical practice. Every few weeks a minor readjustment of stresses in the more rigid outermost skin of the earth gives rise to what is called a major earthquake.

Several hundred seismographs, set up over the world, listen to the bumps and thuds of the earthquake wave as it echoes and reëchoes in the earth's interior. Since the earth is formed in onionlike layers above the core, and since each layer reflects and re-reflects the wave, unscrambling the recorded seismic racket is a complicated procedure. As a means of surveying the interior, this method is about as efficacious as would be the survey of a mountainous region which a blind man could make by shooting off a pistol and timing the echoes from each mountain. However, since we cannot see the interior, we must content ourselves with hearing, and, as a matter of fact, the calculated results show a surprising amount of detail. Professor Louis B. Slichter and Dr. C. L. Pekeris, '29, at M.I.T. are experts in this immensely complicated method of analysis.

Earthquake waves are of three sorts: compressional (called P, or push, waves); transverse (called S, or shake, waves); and, finally, the surface waves, usually the most intense but telling us little about the interior. Each type of wave travels at a different speed, changes from one type to another and back again at each reflection, and each tells its own story at the end of its travel. An analysis of the accumulated data on earthquakes of the last 40 years indicates that the granitic and basaltic material of the earth's crust is about 20 to 50 miles deep. Below this surface of demarcation (which goes by the horrendous title of Mohorovičić discontinuity) are several thicker layers of greater density and rigidity, down to a depth of 1,800 miles, and all presumably made of rocky material considerably denser than granite. This material is, like tar, rigid to sudden shock (S waves can travel in it), but it flows under steady pressure, also like tar. At a depth of 1,800 miles there seems to be another sudden change in material (called the Gutenberg discontinuity). Beneath this depth is the heavier core, much less rigid than the overlying layers, for it does not seem to transmit S waves. Since the P waves travel slower in the core than outside, there is a tendency toward a focusing of the waves at a point opposite the center from the source, just as light is partially focused by a glass sphere. Whether the core material is liquid in the usual sense of the word is rather hard to say, unless we do not mind making statements which cannot be proved and also cannot be disproved.

With her innards partly located, we next turn to the question of Mother Earth's age. Perhaps this is an impertinent question to raise, but its answer will help tell us the history of her own development, as well as telling us about the evolution of that greenish surface mold called Life. Many attempts have been made to determine the age of various features of the earth, from estimates as to how long it might take to increase the salt in the ocean by a given amount, to guesses as to how long it would take to wear down a mountain range from so high. There was even an estimate obtained by guessing how hot the earth was when it was formed and then estimating how long it would take to cool down. This estimate has been viewed with some skepticism, however, since it was discovered that if the earth contains as much radioactive material throughout as it does on the surface, it would not be cooling down, but would be heating up steadily! In fact, one per cent of this radioactive material would still make too much heat to get rid of. It is generally agreed today that we simply do not know enough to make any statement about the earth's temperature, except that there has not been enough time for the earth, since its birth, to come to temperature equilibrium, though it has long since come to almost perfect mechanical equilibrium. The earth has relaxed, so to speak, but it has not cooled off yet.



through the interior of the earth. Just before the cut breaks across the pages, the shake wave comes, and shortly after, the widely swinging, slow surface wave. The quake, of considerable duration, continued its record on the line below the starting line

Since the discovery of radioactivity, however, geologists can dispense with such outlandish methods of guessing and concentrate on utilizing nature's most perfect timepiece. As an example of pigheaded persistence, a sample of uranium beats anything else known to man. Whether the pressure be thousands of tons per square inch or nothing, whether the temperature be millions of degrees or zero, the sample will go to the devil in its own sweet way, disintegrating a definite, fixed fraction of itself each year. During this disintegration uranium produces, among other things, radium and radium emanation (which in turn disintegrate), and helium and lead (which do not disintegrate). The helium comes off at high speed, as alpha radiation, but is soon battered into quiescence by the other atoms in the rock and remains trapped along with the lead as long as the rock is undisturbed. Therefore if we can measure the *rate* of production of helium and lead in the rock today, and the *total amount* of either helium or lead produced in the rock by radioactivity, we can determine how long it has been since the rock was formed. Considerable work on age determination is being done at M.I.T. by Dr. W. D. Urry, Professor R. D. Evans, and their co-workers.

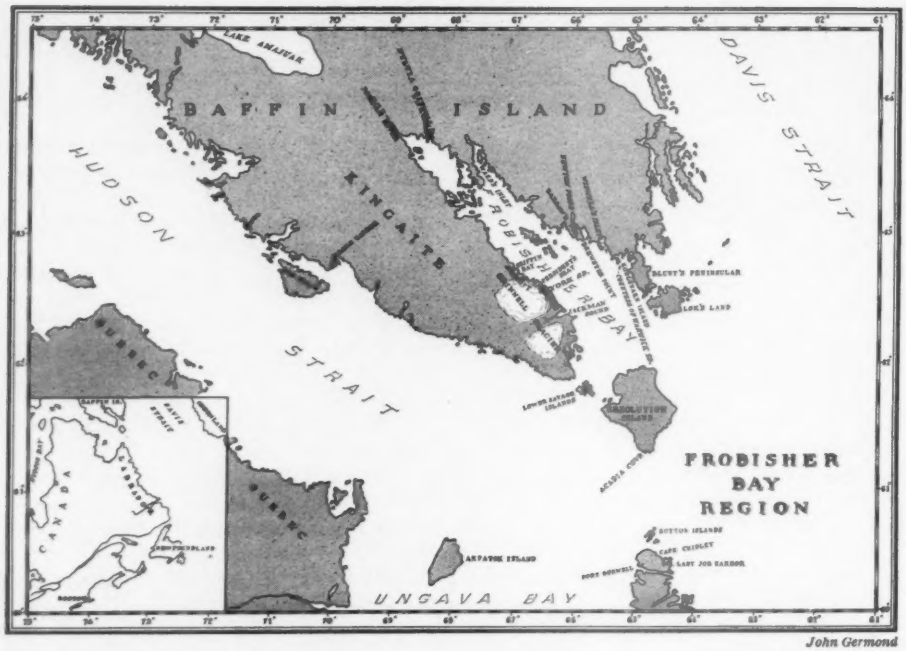
The amounts of material measured are excessively minute, since only a minute amount of uranium is present in ordinary rock. In fact, the amount is so small that the lead produced by disintegration cannot be separated from the lead already there, and the lead-content method must therefore be confined to ores with a high uranium content. This imposes too great a restriction on the sorts of specimens measurable, so that the helium-content method seems at present to be the most generally applicable one. A known sample of the rock is put into a furnace, the helium boiled off, all the other gases removed, and the volume of the helium left is measured. Since this amount, at atmospheric pressure, has the volume of a few grains of salt, it is obvious that every precaution must be taken to obtain a reliable result. The precautions are evidently adequate, for different methods agree with each other to a surprising extent. The measurements of Professor Evans, who uses a vacuum furnace to boil the rock in order to get the helium and who counts the alpha particles to determine their rate of production, check fairly well with those of Dr. Urry, who uses a flux to help boil out the helium and who ascertains the rate by determining the amount of radium emanation. And there is indication that the check will be almost perfect as soon as the reference standards have been completely correlated.

There are a few other methods which have been suggested or used occasionally: One of them, utilizing the radioactivity of potassium, is not satisfactory because the end product, calcium, was usually in the rock at the start; and another, utilizing the radioactivity of rubidium, promises well, but has not been used to any extent yet.

At present only a few time measurements have been made, and these are not especially satisfactory, considering the possible accuracy of the present methods. The chief difficulty seems to be in the so-called geological error in locating from what geological era a given specimen comes. Unfortunately none of the radioactive methods can be used on sedimentary rocks; so that a specimen of igneous rock — a basalt or granite — must be found which came to the surface and solidified during the specified era. Continued collection of specimens and correlation of results will probably remove these difficulties.

The results at present indicate that the beginning of the Tertiary period — the end of the age of reptiles and the beginning of the age of mammals — came about 50,000,000 years ago; the beginning of the Mesozoic era — the age of reptiles — came about 200,000,000 years ago; and the beginning of the Eozoic — the possible beginning of life — came about 500,000,000 years ago. As to the possible age of the earth, no rock has been found which is older than 1,800,000,000 years. This is checked by measurements of meteorites — chance visitors from the rest of the solar system — whose ages vary from a few hundred million to 2,000,000,000. The best guess at present seems to be that the earth's surface solidified (if it did solidify) about 2,000,000,000 years ago. If we compress this time scale into a figurative 24 hours, the time from midnight to 6 P.M. next evening was occupied by the earth in settling down and getting ready for occupancy; at about 6 P.M. Life began; at 10 P.M. reptiles began; since 11:30 mammals have flourished; and from 11:58 to midnight man has strutted. One-fifth of a second has passed since the pyramids. During the day the surface skin has been fairly active: Continents have risen, fallen, and drifted around; mountain ranges have popped up and frayed out in a rather busy manner. Except for the first hour or so, however, the major volume of the earth has been reasonably quiet.

The above time scale is somewhat longer than was fashionable 20 years ago, but it is supported by much of the recent evidence, astronomical as well as geological. It still gives the sun enough time to splash out the earth, or whatever it did; and it gives the primeval chromosomes enough time to mutate, or whatever they did. However, a few more years of coöperation among geologists, geophysicists, physicists, and chemists (plus a bit of financial support) will result in a much more coherent picture. A complete gravitational survey of the earth will clear up many debatable questions about the earth's structure, and an extensive age survey will enable all the rocks of the surface to be arranged in an accurate time sequence. The results will probably inaugurate a new era in the study of historical geology; and I suppose that is an important matter. At any rate, Mother Earth is gradually being persuaded to reveal her age and anatomy.



John Germond

Few places so near civilization are as little known as Baffin Island. Here is an approximate map showing places described in the article below

Spectacular Frobisher Bay

Where Even the Trout Grow Large and Glaciers Drop 2,000 Feet from the Icecaps

By Martin J. Buerger

ITS shores afford the grandest scenery in eastern North America. Its icecaps, the most southerly perpetual inland ice along our shores, are visibly at work fashioning cathedral-like buttresses and spires from its lofty, rocky shores. Its tides rise and fall 55 feet. Its trout approach a fisherman's dream of 2½ feet. Its shore line has risen 180 feet since the ice age.

I speak of Frobisher Bay — the long, narrow, wedge-shaped thrust which the ocean makes into the southern extremity of Baffin Island, north of Labrador. Since my visit there last summer with Lieutenant Commander Donald B. MacMillan's expedition, my enthusiasm for this little-known section has steadily increased, along with the feeling that the region — never accurately

BAFFIN LAND IS RISING

Relieved of most of its ice load following the great Ice Age, Baffin Island apparently rose some 180 feet above the present sea level. Evidence of this rise is shown here by the wave-cut wall of the apron plain near the water's edge. The river, which empties in this cove (Jackman Sound), once meandered over the apron plain. The glowing southeastern part of the Grinnell icecap is visible in the background

FROBISHER BAY

Above. *On a quiet day the author caught, from Brewster Point, this view of the Everett Range, including Mount President's Seat, 30 miles away. Here is a striking example of that arctic phenomenon, cloud glow or iceblink, produced by light reflected from the Grinnell icecap. In the foreground is the MacMillan expedition schooner.*

Right. *View down one of the glaciers from its source at the edge of the icecap, about 2,000 feet high*

GLACIER CLOSE-UPS

Left. *Huge echelon crevasses, or tension cracks, formed by tearing away of the faster moving central ice from the side ice whose movement is reduced by friction with the rock walls. Note the man at the left and the angular granite blocks which constitute the edge of the lateral moraine. The Frobisher Bay glaciers offer an excellent opportunity to study some of the puzzling flow phenomena of glaciers.*

Below. *Toe of the glacier shown above. Water is shown flowing out of an internal drainage channel. Note the geologist's pick for scale*

mapped — is worthy of study by geologist and cartographer. I would even recommend the bay, if you can find transportation, as an ideal destination for a summer excursion. Some details about this magnificent country may explain why.

Discovered by Martin Frobisher in 1576, the bay bearing his name was explored by him for a distance of about 130 miles into the interior of Baffin Island, under the impression that it was the much hoped for trade route to China, the famous Northwest Passage. When Frobisher returned to London to tell of his discoveries, some of the quite ordinary, black amphibolitic rock brought back by one of his crew was incorrectly identified as gold ore, and this precipitated the first gold rush into the northern New World. Headed by Frobisher, an

THE TIDE DID THIS

The MacMillan expedition's schooner, the Gertrude L. Thebaud, *nearly came to grief when an ebbing tide of over 24 feet left her unexpectedly high and dry. Toward the head of the bay the tides are reputed to reach the tremendous height of 55 feet*

expedition set out in each of the two following years, and both times returned laden with black rock. But before the second expedition had returned, the "ore" had already been proven worthless.

The north and east sections of Frobisher Bay were again explored in the years 1860, 1861, and 1862 — this time by Charles Francis Hall. He explored the bay to its very head and thus discovered that this arm of the sea was not a through passage, as Frobisher had supposed, but rather an inclosed body of water. The place names in and about Frobisher Bay are due entirely to Frobisher and his men and to Hall, all of whom named important features after their friends or patrons.

This region has been more recently visited by several expeditions under the general leadership of Lieutenant Commander Donald B. MacMillan. The 1937 MacMillan expedition spent about a fortnight of the summer in and about Frobisher Bay. As a member of this expedition, I felt that I was continuing a Technology tradition, for Professor Alfred E. Burton and George H. Barton, '80, were with the sixth Peary expedition to northern Greenland in the summer of 1896 and, on their way, landed at Lower Savage Islands, just south of the mouth of Frobisher Bay.

Frobisher Bay is reached by sailing along the Labrador coast to Cape Chidley, then across Hudson Strait to Resolution Island, which lies just south of the mouth of the bay. Hudson Strait is an outlet for the pack ice of the Hudson Bay region, and the pack can usually be depended upon to come pouring out of it into the North Atlantic until the latter part of July, preventing a crossing to Baffin Island until this season. The currents in the strait run from five to seven knots, gathering the ice into strings and clots of ever changing configuration and making navigation difficult. The 1937 MacMillan expedition waited six days in the vicinity of Cape Chidley for alleviation of ice conditions, finally making the crossing to Acadia Cove, Resolution Island, on July 27. Several pack clusters were penetrated during the crossing.

The tides in Frobisher Bay are so extreme that they must receive the constant attention of any expedition. At Brewster Point, on the northeast shore, a tide of 24.5 feet was measured, while in Griffin (?) Bay, somewhat farther in along the southwest shore, the tide was nearer

ESKIMO FASHIONS

Women of the Brewster Point Eskimo encampment. The woman's dickey, or parka, differs from the man's by having a short apron in front and a long tail behind, giving them the appearance of oversized beavers — a rigid fashion caused by the polar bear, as explained on page 282

Notice the raw seal meat on the tent, out of reach of the dogs

30 feet. Generally speaking, it can be said that the tides increase toward the head of the bay and are reputed to reach the tremendous height of 55 feet, a figure which places Frobisher Bay among the several regions of the world having very great tides. Naturally it is extremely hazardous to navigate such a body of water. Not only is it difficult to find an anchorage which is suitable both at high and low tides, but the tidal currents are very strong. This is apparent even in the deep water off Resolution Island, in the mouth of Frobisher Bay, where the sea rushes by the rock cliffs of the island in much the same manner that swift water sweeps the banks of an island in a river. The currents are even stronger within the bay itself, especially since the tide ebbs in the extremely short time of three hours or less.

All the maps and charts which show the bay are based upon the one made by Hall in the 1860's. Hall's work, of course, was of a reconnaissance nature and therefore his map is only a sketchy, inaccurate outline of the shores. Indeed, a great part of the bay, including almost the entire southwestern shore, was not actually visited by Hall, although it was tentatively sketched in by him from the opposite shore, some thirty-odd miles away. This coast is consequently indefinite, and the identification of any of its features by (*Continued on page 279*)

There Are Good Germicides

But Some Are So Valueless That Their Purchase Is a Waste of Money

By Cecil G. Dunn

HOW THE BIOLOGIST EVALUATES A GERMICIDE . . . RECENT ADVANCES IN THE CONTROL OF INFECTION . . . THE NEED FOR WIDER PUBLIC KNOWLEDGE OF THE USES AND LIMITATIONS OF ANTISEPTICS . . . THE POSSIBILITY OF INADEQUATE GERMICIDES STIMULATING THE GROWTH OF BACTERIA

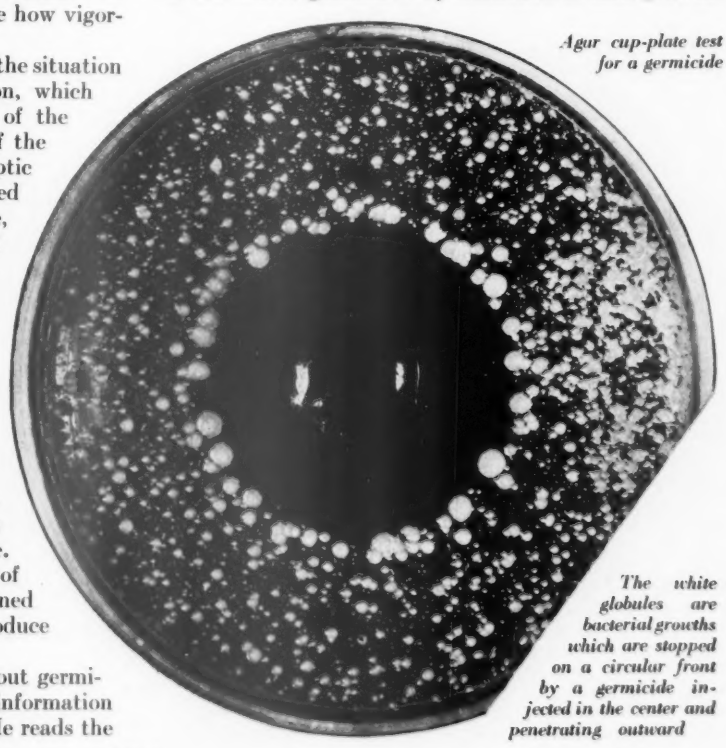
MAN has been made germ conscious. He visualizes in every microbe a menace to his personal safety. How can these public enemies be destroyed or rendered inert? As the result of a demand for germicides and antiseptics to serve these worthy purposes, industries have grown up. Many of these industries are excellent and are pursuing their objectives through careful chemical and bacteriological research, but some are still willing to deal in preparations of so little value that their purchase often constitutes a waste of the public's money. One needs but to enter any of the soda-fountain drugstores to determine for oneself the multiplicity of proprietary compounds, valuable or otherwise, or read current magazines to see how vigorously they are being advertised.

That there has been real improvement in the situation cannot be gainsaid. The following caption, which appeared on one product, is illustrative of the labels occasionally found in the heyday of the not too long ago: "A most reliable antiseptic and germicide. Its action upon all diseased surfaces is not only curative but corrective, reducing inflammation and destroying all disease germs known by all doctors to be the cause of sickness and disease." Thus was advertised the first and probably the last perfect germicide! Although the conditions are changing, were it not for certain regulations and efforts of such agencies as the Food and Drug Administration, various state departments of inspection, and the American Medical and Public Health associations, there might still be on the market a flood of compounds of questionable germicidal or antiseptic value. It is notable, too, that the Association of Germicide Manufacturers is making determined efforts to improve this condition and to produce materials of positive quality.

The average person knows very little about germicides or antiseptics. Frequently, what little information he ascertains comes from inexact sources. He reads the extravagant claims prepared by advertising agencies and is impressed. He gets the opinion of the drugstore clerks who sell the products, but who often know little more of actual fact about the compounds than the prospective customer himself. The great buying public must rely upon the veracity of the manufacturers, upon doctors, the periodicals, the radio, or the word of someone else. The public can rarely get the opinion of the bacteriologist who has made a careful scientific examination.

The words "germicide" and "antiseptic" connote a positive action and in themselves offer a sense of assurance to the buyer. But they are words with varied meanings to the well-informed. It is generally helpful to define such terms as may have divergent meanings. Literally, a germicide is a "substance or agent which destroys germs or microörganisms." We may ask: Under what conditions will it do this? In what dilution? How rapidly does it act?

A term often used synonymously with germicide, but erroneously so, is antiseptic. An antiseptic, as defined by the Food and Drug Administration, is "a substance which, when applied to microörganisms, will make them harmless." This is accomplished either by destruction of the microörganisms or by inhibition of their growth.



Agar cup-plate test for a germicide

The white globules are bacterial growths which are stopped on a circular front by a germicide injected in the center and penetrating outward

When substances, such as gargles or douches, are to be used in contact with the body for a few seconds only, the organisms must be destroyed by the recommended dilutions during the time of contact with the body if the substances are properly to be designated as antiseptics. Substances, such as salves or ointments, which may be in contact with the body for fairly long periods of time may be termed antiseptic if they prevent the growth of microörganisms during the period of application.

By disinfection, in the scientific sense, is meant the destruction of infective microörganisms. The term "disinfection" has, however, had different significance during the passage of time. At one period, before the advent of the germ theory of disease in the 19th Century, the destruction of any putrefactive decomposition or the removal of noxious odors emanating from such matter was considered to be disinfection. From these beginnings arose the idea, still persistent in the minds of many persons, that a strong-smelling substance is a good disinfectant, simply because it masks odors. Today its effectiveness is quantitatively measured by bacteriological tests, and the germicidal strength is expressed by a "phenol coefficient." A phenol coefficient states the potency of a compound toward Staphylococcus aureus, or some other microörganism, at a given temperature, in comparison with the potency of phenol (carbolic acid). For example, if a chemical agent destroys a pathogen in a dilution of 1/30,000 in ten but not five minutes and phenol accomplishes the same result in a dilution of 1/60 under the same conditions, the phenol coefficient is said to be $\frac{30{,}000}{60}$, or 500.

History reveals that the use of chemical agents in preserving and in fumigating is an ancient art. The Egyptians used spices, salts, preservative oils, often with drying, to preserve the human body. The effectiveness of their methods is readily verified. Sulphur was burned in the period of Hippocrates in an effort to counteract plague, and at one time it was used for purifying wool against contagious diseases. Yet in spite of the fact that chemical agents were used for the foregoing purposes, there is no evidence that man thought of using any of these agents to prevent infection of wounds or as a preoperative measure.

McCulloch relates that at the beginning of the 19th Century a woman's chances of living during confinement were about seven times greater at home than in a lying-in hospital. Today this is not true. Before the work of Semmelweiss and Lister, a soldier submitting to a major amputation had approximately one to four chances in ten to live, while a person undergoing a similar operation in a civilian hospital had four to seven chances in ten to survive. Thousands of individuals thus needlessly sacrificed their lives on the altar of ignorance, for the use of disinfective or aseptic methods, such as are now employed, would have prevented most of these untimely deaths caused by infections.

As the result of the careful scientific research of some of our scientific forebears, there has been accumulated knowledge concerning chemical disinfection and disease which has saved untold numbers of lives, prevented infection and sickness, and increased the happiness and well-being of mankind. Around 1800, Cruikshank of England and Guyton de Morveau of France first proposed the use of chlorine as a disinfectant. Lefèvre, in 1843, advocated the use of chlorine water as a disinfectant, and during the same year he and Dr. Oliver Wendell Holmes brought to the attention of the public the contagious nature of puerperal fever. Dr. Holmes adopted the practice of washing his hands with chloride of lime after visiting women who were ill with this fever.

Semmelweiss, a young surgeon, assistant in a ward of a great lying-in hospital in Vienna, observed, in the year 1846, that mortality from puerperal septicemia, a dreaded and deadly disease, was greater in those wards visited by medical students than in wards not visited by them. It was the practice in his ward for students to assist in the autopsy of women who had died from puerperal fever and afterwards to assist in delivery. One day in the hospital a doctor was accidentally cut by the knife of a man who had just completed an autopsy on a woman dead from the fever. The doctor died soon afterwards from blood poisoning. Semmelweiss believed that the high mortality from puerperal fever was unnecessary, and in endeavoring to conquer the disease, he reasoned that the cause of death must be carried, as an invisible poison, from the cadavers to wounds in the patients by the hands or implements. He immediately (1847) ordered all students to wash their hands and to soak them thoroughly in water containing chlorine. At once the death rate from puerperal fever in the hospital dropped sharply. Attention directed to the cleansing of instruments, beds, and linen was amply rewarded, as more young mothers returned alive to their families. The young surgeon, who saved hundreds and ultimately even thousands of lives through his observations concerning the transmission of puerperal fever, was ridiculed for his ideas and practices by many members of the medical profession. But, though it required several years to convince persons of the soundness of his methods and though hundreds of young women died needlessly, the work of Semmelweiss was not in vain.

With the development of the germ theory of disease by such men as Bassi, Henle, Pasteur, Davaine, and Koch (especially Pasteur and Koch), it was but a step to the advent of antiseptic surgery. Dr. Joseph Lister, later Lord Lister, now recognized as the father of antiseptic surgery, first used carbolic acid in operating and in the disinfecting of wounds in the year 1865. This chemical, now usually called phenol, which was discovered by Runge in 1834 and recognized as a disinfectant almost immediately, was likewise used by him as a soak for surgical instruments. It would not be a simple undertaking to calculate the number of lives saved by the use of antiseptic surgery. Had its use been adopted earlier, the medical history of operations would have been far less morbid. Yet this type of surgery, which depends upon the application of chemical solutions to destroy any microörganisms which may be present, was replaced during the latter part of the 19th Century by aseptic surgery, wherein germs are prevented from coming into contact with wounds by the use of the most stringent methods of cleanliness.

The period dating from the germ theory of disease to the present has been a period of continuous experimentation in disinfection. The use of (*Continued on page 284*)

Chemicals That Cure

By Tenney L. Davis

As Dr. Dunn points out in the preceding article, there is a possible relation between chemical disinfection and the rapidly developing science of chemotherapy, the treatment of certain diseases by chemical compounds. Below, Professor Davis gives some of the little-known background of Sulfanilamide, the chemical that has recently skyrocketed into public consciousness and defines that branch of science which seeks and applies chemicals that cure. Another example has just been announced as this article goes to press — the successful use of nicotinic acid to treat pellagra.* The Editor

ABOUT a year and a half ago a prominent politician of Boston lay sick in hospital with a streptococcus infection of the inner ear. A dangerous mastoid operation was indicated, but the skillful physician who was attending him saved him without surgery by the use of the new synthetic drug, prontosil. At that time the drug was beginning to be recognized as one which would kill the Streptococcus haemolyticus wherever the latter might be in the body, but the drug's present wide use was not suspected by the majority of physicians.

The first German patent for prontosil (No. 607,537, granted to Drs. Mietzsch and Klarer) was dated Christmas Day, 1932, and was followed quickly by others, all for azodyestuffs derived from sulfanilamide. The results procured by the use of these substances in the treatment of streptococcus infections were almost too good to be true; they were so remarkable that Dr. Domagk, director of the experimental pathological laboratory at Elberfeld, delayed publication until February, 1935, by which time they had been tested thoroughly and confirmed fully. In 1935, too, Drs. Tréfouël, Nitti, and Bovet in France, in consequence of investigations in the laboratory of Professor Fourneau, made public their finding that the simple substance, sulfanilamide (which we now designate in this country as prontosil album), has the same therapeutic effect as its colored azo derivatives. British investigators made extensive clinical studies. In July, 1936, at the London meeting of microbiologists, the new antistreptococcal remedies were much discussed in conversation, though they formed the subject of no formal lectures or demonstrations, and it is probably there that Drs. Long and Bliss of the Johns Hopkins Hospital, Baltimore, learned of the results which Colebrook had obtained in England. Early in 1937 the Johns Hopkins Hospital, in consequence of sulfanilamide and its derivatives, was running month after month without a single mastoid operation. The opinion prevailed that the new therapeutic agents were effective against Streptococcus haemolyticus infections, perhaps against other streptococcus infections. But for other types of pathogenic organisms, there was no information — and no enthusiasm. Within a year, sulfanilamide has swept the country. It is now believed to be good for all sorts of coccus infections — streptococcus, staphylococcus, meningococcus, gonococcus, and so on. A medical friend tells us that he believes it to be the greatest advance in chemotherapy since salvarsan.

Chemotherapy, like other branches of medicine, proceeds by putting things into, or onto, the body of the patient. It is interesting to distinguish it, on the one hand, from the extremely ancient Galenic therapy, which makes use of plant and animal materials powdered, infused, and decocted and, on the other hand, from the most modern therapy of all, which makes use of biological products, vaccines, antitoxins, and serums. Chemotherapy makes use of pure substances, generally prepared by chemical means. Its earliest important example is, perhaps, the use of sulfur for the itch, a disease which yields neither to the natural resistance of the body nor to galenical drugs. Another example is the use of mercury compounds in the treatment of syphilis, for which disease mercury appears to be specific. And another — the most notable example of recent times — is salvarsan, an organic compound of arsenic prepared synthetically. The case of quinine for malaria is a bit ambiguous, for quinine is a pure chemical substance which is isolated from the bark of a tree. Ephedrine (for asthma, and so on) may be procured from a plant, but much of the material of commerce is actually produced by chemical synthesis. Sulfanilamide and its derivatives do not occur in nature.

During the past year sulfanilamide and its derivatives have saved innumerable patients from the dreaded mastoid operation, from meningitis, from an otherwise fatal blood poisoning caused by the common pus-forming staphylococcus. Many are now living in health who would certainly have died except for sulfanilamide. A year ago it was being tried by a few bold doctors for the treatment of gonorrhea. Today it is suspected of being the panacea.

For gonorrhea, sulfanilamide or some one of its derivatives is administered in large doses. The patient must be watched for untoward physiological reactions — it may be necessary to modify or discontinue the dosage — and in successful cases the infection is completely removed within five or six days. The drug is reported to be especially useful for dealing with old and deep-seated infections. Typical reports indicate that at the public health clinics which are free, where no real supervision of the patients is possible, prontosil for the treatment of gonorrhea is successful in about 10 per cent of the cases; in physicians' private practices, where the patients are probably more intelligent and follow the physicians' directions more carefully, it is about 40 per cent successful; in hospitals, where the patients are in bed and can be watched at all times, it is successful in about 90 per cent to 100 per cent of the cases. It is evident that the remedy must be used under close supervision — and evident, too, that there is reason to hope that gonorrhea may ultimately become as uncommon as smallpox.

Drs. Dochez and Slanetz of the College of Physicians and Surgeons of Columbia University and the Presbyterian Hospital, in a preliminary paper in *Science* (February 11, 1938) report remarkable results in the treatment of canine distemper by means of a new derivative of sulfanilamide, namely, sodium sulfanilyl sulfanilate. It is a white, crystalline substance, easily soluble in water. The dose for small animals is one gram per kilogram of body weight, or about seven grains per pound. Cats, rabbits, and ferrets have been given one gram of the substance every day for two weeks without loss of weight or of appetite or any other unfavorable symptoms. The material circulates in the blood for a short time at a relatively high concentration and is completely excreted within 24 hours.

Canine distemper is believed to be closely related to human influenza. Both diseases are caused by filterable viruses, as are also infantile paralysis and epidemic encephalitis. Sodium sulfanilyl sulfanilate appears to be the first chemical agent which is effective against any of the virus diseases, but the range of its activity remains to be investigated. The preliminary experiments and the extraordinary success of sulfanilamide give us reason to hope that another large group of the dreaded enemies of mankind may be brought under control.

* Pronounced sul-fa-nil'-a-mid'

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Open House

BACK in the spring of 1922, student members of the American Society of Mechanical Engineers at the Institute sent out invitations for an evening tour of the steam and hydraulic laboratory. The success of that evening, much enjoyed by a small group of visitors, led to a somewhat more elaborate program in the following spring, and thus was started an event of great public interest, the Institute's Open House.

This year on Saturday, April 30, Technology will hold its 14th Open House. Instead of a few visitors for an evening, it will entertain some 25,000 guests from two o'clock in the afternoon until 10 P.M.

The program of this year's Open House will have many new and interesting exhibits that will indicate what has been accomplished in various fields in the past few years. There will also be ample evidence of the interests of students in various cultural fields, as in the numerous undergraduate activities, including student publications, the drama, debating, music, and sports.

Open House is planned and managed entirely by the students, through the Open House Committee. The staff coöperates in arranging exhibits and lectures in all departments, a task that occupies the spare time of a large group of the Faculty and students for weeks in advance of the event.

Alumni Day Notes

RECOGNITION of the significance of moving the School of Architecture to Cambridge and of our final departure from Rogers will supply the keynote for Alumni Day on June 6. The committee in charge of plans announces the acceptance of Dr. C.-E. A. Winslow, '98, Yale's distinguished professor of public health, as the speaker at the farewell ceremonies following the symposium in Huntington Hall in the morning.

Dr. Winslow was a member of the Institute's biology staff for a decade following his graduation and, despite his extraordinarily busy professional career, he has been a loyal and active Alumnus. His address should be one of the high lights of the program.

Careful plans are being made to entertain the wives of Alumni during the day. Each year the attendance of women has increased, as more and more Alumni find that their wives enjoy returning to the Institute with them. This year a committee of Technology Matrons, headed by Mrs. Murray P. Horwood, '19, is ready to welcome a still larger group.

On the Corporation

GORDON S. RENTSCHLER, President of the National City Bank of New York, was elected a life member of the Institute's Corporation at its meeting on March 9. Mr. Rentschler had been a special term member since January, 1937. To fill his unexpired term, the Corporation elected Colonel Edward A. Deeds, President of the National Cash Register Company, to special term membership.

Colonel Deeds is a graduate of Denison University, of which he is also a trustee. In addition to being head of the National Cash Register Company, he is chairman and president of the Niles Bement Pond Company, the Shepard Niles Crane and Hoist Corporation, the General Sugar Corporation, and director and president of the Miami Conservancy District. He is a director of the American Rolling Mill Company, the Mead Corporation, and the General Machinery Corporation. Colonel Deeds is a member of the American Society of Mechanical Engineers, the Society of Automotive Engineers, the American Institute of Electrical Engineers, and the Army and Navy Air Service Association. His fraternity is Beta Theta Pi, and he is a member of various clubs.

Like Colonel Deeds, Mr. Rentschler, the new life member of the Institute's Corporation, is a native of Ohio. He was graduated from Princeton in 1907 and is a life member of its board of trustees. He is a director of All American Cables, Inc., the City Bank Farmers Trust Company, Postal Telegraph and Cable Company, International Banking Corporation, the General Machinery Corporation, the Home Insurance Company, the Federal Insurance Company, and many others. He is also a member of the Ohio Society of New York.

The Dewey Library

THE third of the Institute's departmental group libraries, which so efficiently supplement the service of the main Library, has been opened in the Pratt School of Naval Architecture, where it occupies the large room on the third floor formerly used as a lecture hall. The Eastman Library, first of the branches serving several departments, was opened in 1932, for the convenience of the Departments of Physics, Chemistry, and Mathematics. A year later the Lindgren Library, named for Dr. Waldemar Lindgren, former Head of the Department of Geology, was established for service to the Departments of Mining, Metallurgy, and Geology.

The newest of this group has been named for Professor Emeritus Davis R. Dewey, for many years the distinguished Head of the Department of Economics and Social Science. It will provide much-needed library service to the Departments of Civil Engineering, Business and Engineering Administration, Economics and Social Science, Naval Architecture and Marine Engineering, and Mechanical Engineering. The latter department has never had a branch library, and a special selection of mechanical engineering material is now being made by Professor Joseph H. Keenan, '22.

The room occupied by the Dewey Library was completely remodeled and now has a wide balcony of reinforced concrete on three sides, with a capacity of 30,000 volumes. On the main floor are stacks for 19,000 volumes. Reading and reference tables seat 76 on the main floor and 29 on the balcony, where every alcove has a study shelf and chair. By a rearrangement of the ventilating system both the balcony and main floor are exceptionally well ventilated. The walls of the room are a soft pastel green which harmonizes with the color of the stacks and fittings. Special consideration was given to lighting, with the result that a system of overhead holophane flush-ceiling units obviates the necessity for individual table lamps, which are seldom satisfactory for library purposes.

The new library is under the charge of two trained librarians, one of whom supervises books and periodicals of the engineering departments, while the other will have charge of the sections for economics, social science, and business and engineering administration. The libraries will coöperate with the staff of the newly created Industrial Relations Section, which has its headquarters in an adjoining room. Books and periodicals in the labor and industrial field will be located in the library proper, while pamphlets, industrial and labor reports, and miscellaneous material will be filed in the headquarters of the Section.

Construction of the Dewey Library was almost wholly an Institute project, for the work of remodeling was supervised by Albert V. Smith, '20, superintendent of buildings and power, while Professor Walter C. Voss, '32, directed the structural details and Harry J. Carlson, '92, coöperated in reviewing the architectural design.

New Degrees

THIS year the Institute will begin awarding separate graduate degrees in naval architecture and in marine engineering. Establishment of the new degrees was voted by the Corporation at its meeting on March 9, in recognition of the opportunities for specialization in each of these fields in the postgraduate years. Students completing the undergraduate requirements will continue to receive the degree of bachelor of science in naval architecture and marine engineering.

Saturday Courses

A SPECIAL program of week-end courses in modern textile testing and research methods, designed primarily for executives, research directors, and others interested in textile manufacturing, will be given at the Institute on ten successive Saturdays, beginning April 2.

Beginning next fall the present Graduate House, as reported in The Review last month (page 232), will become the Senior House when the graduate students move to the newly acquired Riverbank Court Hotel. Here is a view from the upper stories of the Senior House. In the immediate foreground are the President's house and garden and across the yard lies the Eastman Research Laboratories, forming the east side of the main educational group

The program is under the direction of Professor Edward R. Schwarz, '23, and the staff of the textile laboratory of the Department of Mechanical Engineering.

In addition to demonstrations and conferences, laboratory exercises have been arranged to provide opportunity for a limited number of students to use equipment for microscopical and physical analysis of fiber, yarn, and fabric, and to familiarize themselves with the newer techniques in textile research.

Interesting Technology Women

OUR readers have doubtless been aware, as have we, of the growing interest in museums for children, museums which are more than exhibits, museums which help the child to learn about nature more subjectively than by merely gazing at the stuffed bird in grandma's whatnot. Our readers may not be aware, however, that this movement stemmed from the work of the Children's Museum in Brooklyn, N.Y., under the guidance of our own Anna Billings Gallup, '01. Miss Gallup, who retired in October, can have a justifiable sense of pride in the present status of the work. She writes: "Although I am retired, I am getting letters every day from people in some part of the country who ask for help in starting museums for children. In a consulting capacity I am kept very busy, in spite of my purpose to retire. I shall have to buy a typewriter and learn to use it or else commandeer the talents of someone who loves children and children's museums as much as I do. I believe they will always occupy a tender spot in my heart."

Miss Gallup and her sister, Harriet, '94, were products of the stirring days in Technology life which produced also Marion Talbot, '88, professor and dean of women, emeritus, of the University of Chicago; Charlotte A. Bragg, '90, for many years head of the department of chemistry at Wellesley College; Elizabeth F. Fisher, '95, professor emeritus and former head of the department of geology at Wellesley; Katharine Blunt, '03, President of Connecticut College; and, in earlier days, the late Ellen H. Richards, '73. It was Harriet Gallup who later became the first woman chemist in the employ of the Eastman Kodak Company and who, in 1897, became the wife of Darragh de Lancey, '90, whose association with George Eastman became of such significance to the Institute and whose death, for his own sake, was mourned by us this winter.

Born of Brewster lineage on an ancestral farm in Ledyard, Conn., November 8, 1872, Anna Gallup spent her early years in a farming community. Peaceful the environment was but not sleepy. Of her mother Miss Gallup says: "She was wide awake. She liked to discuss public affairs and would start a conversation with anyone who came to the house. Every day all her life she read the New York *Times*. She was fond of travel and never missed an opportunity for it."

This alertness and largeness of view Mrs. Gallup passed on to her children, and it was her courage and perseverance that kept the family going when, while Anna was still a small child, Mr. Gallup died, leaving her with Christopher, Anna, and Harriet. While Anna went to the simple school in Ledyard, the country was still an integral part of her being. When she was 15 years old the farm was sold, and she went to California to visit relatives, returning for a two-year course in the New Britain, Conn., Normal School. There she received an honor certificate for excellence in teaching. "I was greatly surprised, for I hadn't known that I excelled." Apparently, teaching was for her a thing she liked to do and therefore did well, but we surmise that at that time she was preparing more to aid her mother with the burden of finances than to establish herself in any preconceived career.

The next three years Miss Gallup spent in charge of the model ungraded school at Hampton Normal and Agricultural Institute in Virginia, where she illustrated teaching methods to the students and was assisted by them. From here she went back to New Haven, Conn., to teach. Throughout this period Miss Gallup had dreamed of college but seldom as something attainable. There was little money available and, what is more important, she did not, herself, know what subject she wanted to pursue. The touchstone to her future was provided through the dynamic personality of a cousin-in-law who chanced to visit when he had with him a volume concerning the natural history of the frog. Biology at once presented itself to the country-bred girl as a subject she wished to explore.

With this impetus, she spent a year reviewing at the Norwich, Conn., Free Academy, and, in the following fall, entered Tech. Here she taught evening classes and supervised study halls to augment the $125 with which she launched herself on a four-year course — the only woman in her classes. When she had been graduated, Miss Gallup went back to teaching, this time at the Rhode Island State Normal School. But she had grown to feel that "the teaching system killed spontaneous effort" and in her courses she inserted collecting trips, the making of cultures and mounts, and the use of the microscope.

At this time, 1902, the Brooklyn Institute of Arts and Sciences, under Professor Franklin W. Hooper, was seeking to enlarge its scope. Already it furnished outstanding instruction to train teachers in biology. The Children's Museum, under its guidance, occupied two rooms in the Spanish Adams House (it now fills two buildings), but the teaching methods depended upon collections and equipment which were not available in other classrooms. Professor Hooper, in his search to benefit the museum, asked the late William T. Sedgwick of M.I.T. to recommend an assistant. And so it came about that Anna Gallup, with her enthusiasm and whole-hearted interest in helping teachers and children to become acquainted with the world about them, revivified the Children's Museum.

Here she spoke informally with individual children in the galleries, until her audiences grew to lecture-room proportions. She originated the plan of allowing children to take loan exhibits home, so that they might study them more thoroughly and discuss them with their friends. She found that when it was necessary to do any of the work on the scenes in the exhibition halls themselves, the children wanted to watch, and, mindful that one learns best from participation, she arranged for them to help. For the ensuing 35 years, Miss Gallup has given her energy and delight to this work, inspiriting

children who have themselves grown to see successful fulfilment of the ideas she engendered. In May, 1930, the National Institute of Social Sciences presented her with its gold medal "for distinguished service to humanity as curator-in-chief of the Children's Museum for more than a quarter of a century."

Last December, Miss Gallup was recalled to Brooklyn from her newly assumed residence with her brother in Connecticut, to deliver a lecture, and on this occasion the Auxiliary of the Museum gave her a luncheon in the ballroom of The Plaza in New York City. The Review echoes the appreciation shown Miss Gallup by this group, and to her offers the best of wishes for the future.

Visiting Committee Reports

LAST autumn a large portion of the President's annual report was devoted to the work and recommendations of the "Committees of Visitation" appointed by the Corporation for each department of the Institute. Said President Compton: ". . . I am most happy to pay a tribute to the very great stimulation and assistance in many ways which these visiting committees have given to the administrative officers of the Institute."

The Review, as its regular readers know, publishes in condensation most of the reports of these committees. This month the series is continued by the report of the Committee on the:

DEPARTMENT OF PHYSICS *

THE Chairman laid before the Committee an itemized list of all of the investigations that were currently being conducted by the Physics Department, this list having been prepared by Professors Slater and Harrison. Various members of the Committee also visited the laboratories and inspected certain of these researches. The committee members expressed their appreciation of the skill with which certain of these investigations appeared to be conducted, and they also felt that many of them offered great promise in opening up new fields of research.

Most of the time of the Committee was devoted to the high-voltage program of the Institute. Not only did they inspect the high-voltage work being conducted at the Institute itself, but they also visited both the Collis P. Huntington Memorial Hospital, where the million-volt generator had been installed for Harvard University, and the installation at Round Hill, where the large generator there was in operation. The Committee was impressed with all this work and the able way in which it appeared to be conducted. They were informed at the hospital that the generator there had been turned over to Harvard University some two months previously, that it had been in continuous operation without any major breakdown during this time, and that, on the average, six or seven patients were being treated every day with million-volt x-rays. Thirty-one different persons had so far undergone this treatment. At Round Hill, the Committee was impressed with the skill and perseverance of the staff, where the work has been carried on under extreme physical difficulty.

The Committee unanimously agreed to submit the following recommendations:

1. The high-voltage nuclear research program of the Institute should be continued and pushed with vigor.

2. A model generator should be constructed and used for experiments looking to improving the usefulness of electrostatic generators, with special reference to the possibility of operating such generators in pressure chambers filled with compressed air and/or compressed vapors. It is suggested that this may fit advantageously into the existing high-voltage program in the Electrical Engineering Department. . . .

*Members of this Committee for 1936–1937 were: Alfred L. Loomis, Chairman, Martin H. Eisenhart, '07, Harlow Shapley, the late Frank A. Vanderlip, Bailey Townshend, '16, William D. Coolidge, '96, Henry A. Barton, and Arthur H. Compton.

The Late Dr. Hale

BY H. M. GOODWIN

GEORGE ELLERY HALE, '90, died at Pasadena on February 21 after a long illness resulting from a nervous breakdown due to many years of intensive work. With his passing, astronomers mourn the loss of "the greatest builder of American astronomy"; the country, one of its foremost citizens; and Technology, her most distinguished son.

To give in the short space allotted here any adequate account of the discoveries upon which Hale's fame as a scientist rests would be quite impossible. An endeavor will be made, however, to indicate the various fields in which his extraordinary ability found expression and to convey some idea of his inspiring and lovable personality.

George Hale was born in Chicago on June 29, 1868, of New England ancestry of the finest traditions. He entered the Institute in 1886, graduating with the Class of '90 from the Course in Physics. He knew at the beginning of his college days — indeed long before — exactly what he wanted to do in life, namely, to follow a career of scientific research in astrophysics and astronomy. He was a born investigator; to experiment was for him an exciting adventure. Fortunately he had a wise and understanding father, who early recognized his unusual abilities and provided him with every facility for developing them, building for him at his home a spectroscopic laboratory and, after his graduation from Technology, the Kenwood Observatory.

While a student in his junior year, he selected as the subject of his thesis, "The Photography of the Solar Prominences," to accomplish which he invented the spectroheliograph. As the Institute had no telescope with which to form an adequate image of the sun, Professor Edward C. Pickering, director of the Harvard Observatory, placed one of his telescopes at Hale's disposal and, on April 14, 1890, the first spectroheliogram was made. The spectroheliograph has unquestionably contributed more to advance our knowledge of solar phenomena than any other invention since the time of Galileo.

Hale's ability as an investigator was immediately recognized; two years after graduation he was appointed by President Harper to the faculty of the newly founded University of Chicago. By 1895 he had established at

George Ellery Hale, '90 (1868–1938), from a portrait by S. Seymour Thomas hung in the National Academy of Sciences

Williams Bay, Wis., the Yerkes Observatory, with its 40-inch refractor, the largest telescope of its kind in the world. During this period he also inaugurated and edited a new journal, the present *Astrophysical Journal*. After successfully directing the work of the Yerkes Observatory for 10 years, he resigned in 1905 to take up the development of a still greater project at Pasadena, Calif., that of the Mount Wilson Observatory of the Carnegie Institution of Washington. There he built the 60-inch reflector — the mirror a gift of his father — and the great Hooker 100-inch telescope. Here, too, an entirely new type of telescope, the tower telescope, especially designed for solar work, was put into successful operation.

Finally, it was Hale, who, pointing out the possibilities of still larger telescopes, was entrusted in 1928 by the Rockefeller Foundation with the construction of the great 200-inch reflector of the California Institute of Technology, now being erected at Mount Palomar. It is a sad disappointment that he could not have lived to see this, his crowning achievement in telescope building, completed. The design and construction of novel apparatus to meet the requirements of new problems was to him a delight, and an optical shop and machine shop were considered essential.

In 1923 because of persistent ill-health, Hale felt obliged to resign the directorship of the Mount Wilson Observatory. The Carnegie Institution immediately appointed him honorary director in charge of general policy. From that time until his last illness he carried on his research work at his private solar observatory in Pasadena, always in close coöperation with the work of the Mount Wilson Observatory.

Hale was a keen judge of men and surrounded himself with a staff of the ablest colleagues. The splendid contributions from the Yerkes and Mount Wilson observatories bear witness to the efficiency of his administration. His published papers and his annual reports reflect his modesty and desire to give the fullest credit to his associates. He was much in demand as a writer of popular science articles because of his lucid literary style, and his books dealing with various aspects of astronomy are delightful reading. Of his own contributions to astrophysics the discovery of the magnetic field in sun spots and their vortex character, the 22-year cycle of sun-spot polarity, and the general magnetic field of the sun are probably the most outstanding.

In 1902, only 12 years after his graduation, Hale was honored by election to the National Academy of Sciences. He at once became one of its most active and influential members, serving as foreign corresponding secretary for many years. He was primarily responsible for establishing the National Academy *Proceedings*. In 1916, foreseeing the probability that the United States would be drawn into the World War, he conferred with President Wilson, with the result that the academy was asked to organize the scientists of the country to assist the government in any problems which might arise. Thus was formed the National Research Council, with Hale as its first executive officer. When the United States entered the War, he gave up all scientific research and devoted himself entirely to this government service. After the War he was elected honorary chairman of the National Research Council and served also as president of the International Research Council.

Another of Hale's activities in connection with the academy was the planning of the beautiful National Academy Building in Washington, and, as chairman of the building committee, raising the money for its erection. His success in securing funds to finance the enormously expensive projects which he undertook was due to recognition of his sound judgment and confidence in his complete disinterestedness.

Hale's interests and activities were not limited to the work of his observatories and the National Academy. Believing profoundly that research in pure science is the foundation upon which applied science rests, and that in a technological school this should receive the fullest recognition, he was the leading spirit in the transformation of the Throop Polytechnic Institute of Pasadena into the California Institute of Technology. He also held that every engineer should have a broad cultural background and that, therefore, the humanities should form an essential part of an undergraduate curriculum. With these principles fully recognized as the basis upon which the new institution was to be developed, he was able to induce Robert A. Millikan, Arthur A. Noyes, '86, and later Thomas H. Morgan to head the departments of physics, chemistry, and biology, respectively, and William B. Munro that of history and government. As a member of the executive committee, he gave liberally of his time to the development of the school, now recognized as one of the leading research institutions in science.

The Huntington Library and Art Gallery of Pasadena is another institution in which Hale was greatly interested and of which he was a trustee. As a result of a plan which he suggested, Mr. Huntington modified his magnificent gift so that it became not only a great memorial but also an institution for research.

It is gratifying to know that George Hale and his work were fully appreciated during his lifetime. The number of honorary degrees conferred upon him by leading universities of the world, his membership as honorary fellow in foreign academies, the many distinguished medals presented to him, and the decorations bestowed upon him by foreign governments are indicative of the honor and esteem in which he was held throughout the scientific world. His interest and participation in public affairs was recognized in Pasadena by the presentation of a medal for his work in connection with the city planning commission. The last graceful tribute paid to Hale, which touched him deeply, was a symposium arranged by Dr. Harlow Shapley in April, 1936, and held at the Harvard Observatory. At this symposium Hale's life work was reviewed by a number of his friends and colleagues, and congratulations and sincere wishes for many years of health to continue his great work were sent to him in Pasadena.

Hale always had a deep interest in the work of his Alma Mater and served as a term member of the Corporation from 1907 to 1912. He felt, however, for many years that the importance of fundamental research in science was not sufficiently recognized. It was, therefore, a source of very great satisfaction to him in recent years to see how, under the research policy initiated by President Stratton and extended by President Compton, the Institute has forged ahead, until today it stands as one of the leading research institutions of the country. When the Institute moved to its present site, Hale contributed generously for the purchase of special apparatus for the Department of Physics; with a portion of the Hale Fund a spectrohelioscope, his most recent invention for viewing solar phenomena, was purchased with the expectation that the Institute would be able to coöperate with him in a world-wide program of keeping daily records of solar activity. Unfortunately it was found that the ground upon which the Institute rests is too unsteady for mounting this delicate instrument. The equipment is, however, very appropriately now set up in the Harvard College Observatory grounds where Hale carried out his first experiments with the spectroheliograph 48 years ago.

The foregoing sketch indicates the wide range of Hale's activities, but no words can adequately picture his personality, which inspired all who knew him and endeared him to his friends. His interests seemed boundless; he had a discriminating taste in literature, art, and music; widely traveled, his acquaintance included distinguished men the world over. Blessed with a delightful sense of humor and love of fun, he was a raconteur of rare charm and to hear him relate personal experiences to an intimate circle was an occasion never to be forgotten. The memory of George Hale, cherished by his friends, is a very happy one. Great scientist, public-spirited citizen, perfect gentleman, loyal friend: We shall not see his like again.

SPECTACULAR FROBISHER BAY

(*Continued from page 270*)

comparison with Hall's map is a matter of the greatest uncertainty. Needless to say, the absence of suitable charts makes navigation in Frobisher Bay still more difficult.

Although diminutive glaciers and glacierets of the mountain type occur in the mountains of northern Labrador, the most southerly point along the eastern American shore line where a true icecap can now be seen is on the southeastern part of Baffin Island. This region, a peninsula which is bordered by Hudson Strait to the south and by Frobisher Bay to the north, is known as Kingaite by the Frobisher Bay Eskimos. Its icecaps ought to be well known, but are, on the contrary, unknown. Hall made his one visit to this section of the bay in order to ascend its perpetual ice in the vicinity of his Mount President's Seat. His brief description appears in his "Arctic Researches" (pages 516 to 521), but this seems to have escaped the attention of systematic glaciologists, and Hall's Grinnell Glacier is still unknown to them.

From Eskimo accounts, Hall was led to believe that his Grinnell Glacier extended about 100 miles along the southwest coast of Frobisher Bay. Last summer's reconnaissance, however, made it appear likely that this is much too generous an estimate; it probably extends only some 40 miles, or even less, along the bay. It was also discovered that this stretch of perpetual snow does not represent one icecap but two, between which extends a major transverse valley, filled with fluvioglacial deposits and carrying a very important river. This unnamed drainage channel, which is joined by another unnamed river only two miles inland, empties into a very large cove, tentatively identified as the Jackman Sound of the Frobisher expeditions. Near the river inlet, the freshened waters of the cove teem with gigantic trout, about 2½ feet long.

The two icecaps are nested in radically different topography. The southeast icecap sends no glaciers down to the sea, and the coast topography therefore retains the rounded forms left by Baffin Island's earlier continental ice sheet. In sharpest contrast with this is the topography fringing the northwestern icecap. This area of inland ice sends down numerous glaciers into the bay, and these, reinforced by cirque action, have gouged deeply into the original land surface, leaving exceedingly sharp, interglacial spurs. Hall called this fretted upland the Everett Range. It rises some 2,000 to 3,000 feet directly out of the bay, and, capped by its mantle of perpetual ice, it constitutes a bit of the most rugged and picturesque topography in all of eastern North America. The razor sharpness of the spurs of the Everett Range is probably unsurpassed anywhere.

The present distribution and activity of inland ice in southern Baffin Island is interesting. It is confined to high land in the Kingaite region and is absent from the northeastern shore of Frobisher Bay, which attains heights of only about 1,000 feet. The ice is therefore conditioned primarily by elevation. Of the two Kingaite icecaps, the southeastern one is located on somewhat lower ground and is also exposed on slopes of more

southerly-facing tendency. It consequently wastes away by evaporating and melting rather rapidly, and does not spill over to form glaciers running down to the sea. Its northwestern neighbor, on the other hand, not only occupies higher ground but also is not exposed on southward-facing slopes. Its ice thus melts and evaporates less rapidly, and so accumulates and spills over to send glaciers down to the sea. The northerly-facing slopes of this region, largely shielded from the direct rays of the sun, also harbor snow slopes which develop cirques and small mountain glacierets much like those of northern Labrador. The President's Seat, a gigantic, armchair-shaped amphitheater, is an excellent example of this, and there are numerous other lesser ones.

No glaciers from this inland ice reach Hudson Strait water. This lack of glaciers on the southern slopes of Kingaite and the nonextension of the inland ice itself to Hudson Strait shores can probably be traced to the wasting of névé and ice in the sunlight of these directly illuminated, southward-facing slopes.

Some of the members of the MacMillan expedition spent a day in climbing one of the ice tongues back to the northwestern icecap. Two members (Wynne-Edwards and Edwards) climbed to the icecap by way of an adjacent rock spur. They found the height of one of the local, flat ice domes to be about 2,800 feet. Hall had measured the height of the ice as 3,500 feet next to the President's Seat — the highest region in Kingaite.

I was especially interested in the ice tongue itself and spent some time studying various aspects of it during the ascent to the icecap. This particular tongue was a relatively small one, perhaps 800 feet across and some 10 to 15 feet high where it broke off into the sea at high water. Of course, this visible height does not represent the true height of the ice front, for much of the nose of the glacier was buried in its own terminal moraine or under water. The glacier, which is about five miles long from sea to icecap, has sawed a slot for itself out of solid rock, leaving almost vertical walls hundreds of feet high. The talus from these steep sides is continually being removed to the sea in the form of lateral moraine.

The approach to the glacier was characterized by a milky sea, an indication of the load of rock flour which is produced by the grinding action of the ice. Out of the ice front poured a stream of water into a puddle in the terminal moraine, a picture reminiscent of the horse drinking troughs of former days. The ice front itself was very interesting. It was composed of a compact mosaic of grains averaging about walnut size but ranging up to, perhaps, two inches across. Each grain was a true, single ice crystal, proof of which was supplied by the swarms of flat air inclusions, all with flat sides parallel.

The glacier ice is strikingly colored. In addition to the neutral ice color, streaks and areas of the most intense but somewhat pale blue occur. Such areas probably represent healed crevasses and new ice generally. This beautiful blue tint is also found in the small icebergs formed from the local glaciers.

Much of the glacier surface is dotted with tiny rock particles, blown there from the talus piles by the strong wind. These particles absorb the sun's heat and melt the ice beneath themselves to form holes, into which they sink. The black particle at the bottom of each hole makes the hole appear to open into nothingness, and the area gives the impression of a thin crust of honeycombed, rotten ice which might crush through to an interior cavern under one's step. The footing is, of course, quite sound.

No important central crevasses occur in the tongue except where it originates as an ice stream spilling over from the icecap. The central crevasses here are cracks due to the sharp, downward bend in the ice at this initial drop. Below this position the ice takes on a rather uniform, steep slope, and the central crevasses close up and heal. New crevasses occur only along the sides, where diagonal tension cracks develop. These point backwards toward the center of the glacier, giving evidence that the central ice moves faster than the ice near the walls.

The MacMillan parties climbed the glacier on July 29. At this season the surface was running with water which gathered itself together into streams. These ordinarily disappeared by dropping into the side crevasses, but near the foot of the glacier, where no crevasses occurred because of lack of walls to slow down the side ice, swift streams of considerable erosive power developed and entrenched themselves in small ice valleys which were impossible to cross.

The icecap from which the glaciers descend is a gently domed surface whose steepest regions slope only a few hundred feet per mile. It is entirely covered with a deep mantle of granular snow. Into this, one sinks knee-deep, making traveling very tiresome. The ice itself is visible only in one or two steep, wind-swept places near the edge of the ice field, where dull, grayish ice projects from its snowy mantle. The word "wind-swept" is used advisedly, for the heavy, ice-chilled air pours down the ice tongue surface with great velocity, pushing against anyone making an ascent.

There are many indications in the Frobisher Bay region that the present icecaps are only diminutive representatives of a great ice sheet which once not only covered Baffin Island but also extended out into the sea surrounding the land, like the present-day Ross Barrier of the antarctic regions. The northeastern shore of Frobisher Bay displays the rounded land forms characteristic of heavily glaciated regions, and many of the inlets along this shore are typical fiords. While glacial striae are uncommon, due to the rapid arctic weathering, *roches moutonnées* occur on the highest mountains, evidences of the glacial plucking which they have received. The ice came mainly from the northeasterly direction, following to a considerable extent the line of strike of the metamorphosed sedimentary rocks, but occasionally cutting across this from a more northerly direction. The ice certainly extended out beyond the land mass of Baffin Island as far as Resolution Island, which shows an extreme case of glacial plucking from the same general direction. Some 20 miles of deep sea separate Resolution Island from the Baffin Island land mass, and this gulf must have been spanned by a fringe of continental ice.

The great weight of the Pleistocene ice in Baffin Island indented the somewhat yielding crust of the earth. At the close of the Ice Age, the melting of the ice sheet and the consequent decrease of the enormous ice load permitted the land to recover slowly (*Continued on page 282*)

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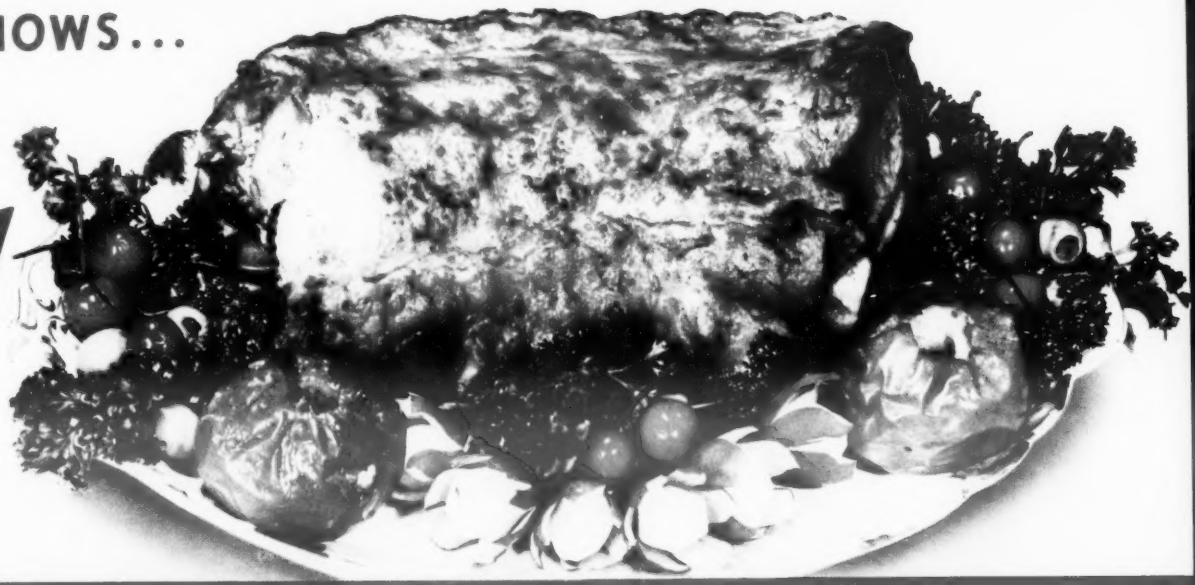

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XVIII

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SPECTACULAR FROBISHER BAY

(*Continued from page 280*)

its normal level, and Baffin Island started to emerge from the sea, a process which added somewhat to its land area. The story of this emergence is neatly outlined on certain of the islands of Frobisher Bay. Kodlunarn Island, for example, the scene of Martin Frobisher's "gold" mining operations, has a surface marked by a succession of gravel and shingle beaches up to its very top, now 55 feet above high tide. Each of these represents a stage in the shore line of the island at an earlier period of its history. The island has certainly emerged at least 55 feet out of the sea, but this is not a measure of the total emergence of the entire area, for the island was doubtless under water during the earlier stages of the rise of the region from the sea. The river entering Jackman Sound (?) on the Kingaite side of the bay gives a better idea of the total rise. This river once meandered over an outwash plain common to the two icecaps which it separates. The outwash plain now stands some 180 feet above high tide, and the river has entrenched its meanders nearly down to sea level. Since the river probably always emptied directly into the sea, and since it once ran over the surface of its now elevated outwash plain, this 180-foot difference between its old and new levels probably gives a good estimate of the rise of the Kingaite coast out of the sea.

The 1937 expedition encountered no Eskimo inhabitants on the rugged Kingaite shore, although Frobisher's expedition found them in the vicinity of Jackman Sound in 1577. On the less severe northeastern coast, however, two very small settlements were found, one at Brewster Point, and the other near Wiswell's Inlet.

The Frobisher Bay Eskimos are nomads: They have no definite home but follow the seals and walruses from place to place. During the summer season they live in tents made either of sealskins sewn together or, perhaps, of canvas if they have been fortunate enough to obtain some by trading. The Brewster Point Eskimos had a couple of old whaleboats which, it was learned, were recovered from arctic wrecks. They also use the usual sealskin kayaks (which have a very strong odor because they are rendered waterproof with the all-purpose seal oil).

These Eskimos, in common with other branches of their race, are incredibly dirty according to our standards. Nevertheless, the women have a sense of fashion, for they own two dickeys (the eastern equivalent of the Alaskan parkas). One of these is usually made of the Hudson's Bay Company's duffel, which is blanketing sold by the yard. This dickey becomes extremely dirty through everyday wear. The second dickey is used mainly on visiting occasions and is a work of art in sealskin. Even the Eskimo women have an eye for good furs, and the best skins — those from the ranger seals found in fresh-water inlets — are used for their dickeys. They are laboriously pieced with strips of black fur to give an inlaid effect of great beauty, the pattern of which is a characteristic of the district. In accordance with tradition, a woman's dickey is always made with a long tail. Legend has it that a polar bear once attacked a woman, mistaking her for a (*Concluded on page 284*)

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SPECTACULAR FROBISHER BAY

(*Concluded from page 282*)

man, and since that time women have distinguished themselves for the benefit of the bears by wearing dickeys with tails. It is said that the bears respect this sign and confine their attentions entirely to men. The men of southern Baffin Land get along with very simple dickeys made of common sealskin far inferior in quality to that used by the women. They are without tails but have the characteristic regional peculiarity of a V-shaped slot cut out of the bottom front.

With these interesting people, with its magnificent scenery and great icecaps, with its challenging unknowns and geologic interest, Frobisher Bay deserves both scientific exploration and sight-seeing excursions. I hope that both will be made.

MAIL RETURNS

(*Concluded from page 252*)

such a particle under the microscope, using an instrument known as the micromanipulator. What really is new in Dr. Kemp's excellent work is the assumption that the hydrocarbon in the inside of the particle has water emulsified therein. However, as he himself says, "Further study of latex particles is needed to answer this question." (Quoted from Dr. Kemp's paper, *op. cit.*)

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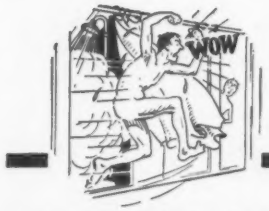

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POWERS *SAFETY* SHOWER MIXERS

THERE ARE GOOD GERMICIDES

(*Continued from page 272*)

chlorine, phenol, acids, spices, antiseptic oils, and other substances as disinfectants was known previous to this period, but very little knowledge was available concerning the actual value of some of these agents. The production of new compounds with high germicidal potency and relatively low toxicity marks the very modern era of chemical disinfection. Phenol coefficients of from 200 to 800 are now not uncommon. To illustrate: The compound, alkyl-dimethyl-benzyl-ammonium chloride, has a phenol coefficient of 400 when tested against Staphylococcus aureus and 570 when a strain of Streptococcus haemolyticus is used as the test organism at 37 degrees C. A phenol coefficient of 750 has been obtained with 3.5-dimethyl-2-benzyl-4-chloro-phenol, using Staphylococcus aureus at the same temperature. By changing the structure and chemical constitution of compounds, it has been possible to bring about very favorable results. Mercuric chloride, though a good germicide in some respects, is extremely poisonous. Its use is not without certain dangers, especially in the home. Merthiolate is a mercurial but is not nearly so toxic as mercuric chloride and is a far better germicide. Another mercurial, metaphen, is also more powerful than mercuric chloride as a germicide and at the same time is said to be relatively nontoxic. A 1/1,000 aqueous dilution of alkyl-dimethyl-benzyl-ammonium chloride has been substituted for drinking water for laboratory animals without observable ill effect to the animals. Were it not for selectivity of action toward different types of cells, these unusual results would not be possible. The chemical agent must possess a high degree of toxicity for microörganisms but simultaneously have relatively low toxicity or irritative action toward the tissues of animals.

If, in addition to possessing high germicidal efficacy, a substance possesses also strong inhibitory properties (bacteriostasis), it is of distinct advantage, since reinfection is retarded. Most mercurials inhibit the development of certain bacteria, in particular Staphylococcus aureus. Metaphen, merthiolate, phenylmercuric nitrate, mercuric chloride, o-hydroxyphenyl-mercuric chloride, and mercurochrome are examples of this group of antiseptics. The last is much more effective in an alcohol solution than in water. Chlorine-liberating compounds usually demonstrate inhibitory action toward some types of microörganisms. Alkyl-dimethyl-benzyl-ammonium chlorides have demonstrated a high degree of bacteriostasis toward some Gram-positive bacteria. (Bacteria may in general be divided into two large groups: Gram-positive and Gram-negative bacteria, depending upon their reactions to certain staining reagents.)

Since the research of Churchman in 1912 and subsequent years, much attention has been focused on the use of dyes in medicine and in the laboratory to inhibit the growth of undesirable types of bacteria, while having but little effect on certain desirable microörganisms. Specificity of action is thus a most important characteristic of the dye. There are three main groups of dyes which are useful on account of their ability to inhibit or prevent growth of microörganisms. These include the triphenylmethane, or rosaniline, (*Continued on page 286*)

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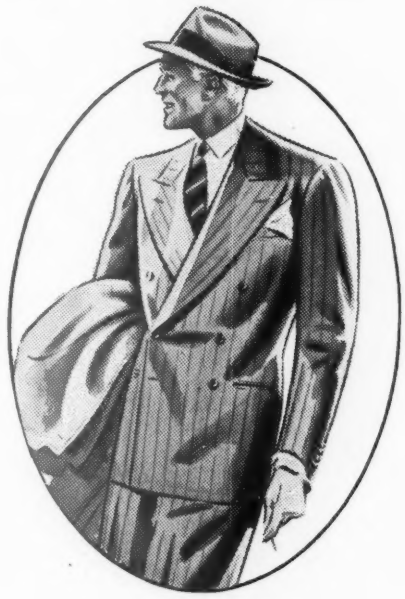

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THERE ARE GOOD GERMICIDES

(Continued from page 284)

dyes, the acridine dyes, and the fluorescein dyes. Gentian violet, crystal violet, methyl violet (all closely related), and fuchsin are well-known members of the triphenylmethane dyes. Some of these dyes are capable of inhibiting the growth of Gram-positive bacteria when diluted several million times. Gentian violet has shown value in the treatment of wounds and burns, while brilliant green, another member of this group, is used in the sanitary analysis of water. Acriflavine hydrochloride (acriflavine), acriflavine base, and proflavine are bacteriostatic agents of worth. Their action is considerably reduced by the presence of blood serum, however. Mercurochrome is a well-known example of the fluorescein dyes which are used in medicine.

Garrod and others have shown clearly that the maximum dilution of the chemical substance at which inhibition takes place is dependent on the concentration of microörganisms present. For example, a concentration of one part of phenylmercuric nitrate in 1,280,000 parts of solution prevented the cocci which were present in 0.1 cubic centimeter of an undiluted culture of Staphylococcus aureus from growing (there are several million bacteria present in 0.1 cubic centimeter of a broth culture), while one part of chemical in over 20,000,000 parts of solution prevented growth when there were only about 400 bacteria present.

Many of the failures resultant from the use of chemical germicides could be prevented if the persons using them had a more extensive knowledge of their purposes and limitations. There are certain dangers which may be encountered in the use of germicides. These may be due to the fact that the agent possesses high toxicity; or it may be ineffective in the presence of organic matter; or it may demonstrate specificity of action. Dangers may also result from the preparation of a solution of the chemical substance with the wrong type of solvent or the failure of the substance to make contact with the desired site. The agent may even stimulate the growth of some of the types of microörganisms which it is designed to destroy.

Some germicides possess high bactericidal potency but, due to their high toxicity, are valueless as germicides for use on the skin, in wounds, or for other medicinal purposes. All germicides, whether powerful or weak, usually have some toxic effect upon tissues. It is necessary, therefore, to determine what concentration of the chemical agent can be safely employed. This may be accomplished by experimentation with animals, such as rats, mice, guinea pigs, rabbits, monkeys, or by tests carried out on man. Tests with human subjects are advocated wherever possible. Clinical evidence from not one but hundreds or even thousands of cases is to be sought. Some of the mercurials have limited solubilities or are far too toxic, if used in concentrated solution, for medical purposes.

From careful laboratory and clinical tests, there should be made a determination of the range of permissible concentrations of a substance. On the one hand, the substance must be sufficiently strong to destroy germs under the conditions of its use, and on the other

hand, it must be of such dilution that undue injury will not be done to the tissues. The primary purpose of the chemical agent is to destroy any pathogens which may be present and to prevent reinfection. If it fails to do these things or if it actually destroys tissue or prevents normal healing processes from taking place, then it is without value and it may even be dangerous. Phenol, for example, is a powerful germicide, but it is very toxic to tissues. Its use, accordingly, must be confined to other types of disinfection, such as the disinfecting of stables. Laboratory tests have proved of great value in determining the effect of organic matter on germicides. The organic matter employed may include blood, saliva, urine, fecal material, agar, starches, gelatin, or yeast cells, depending upon the use to be made of the germicide. Many compounds now on the market, and labeled germicides, are ineffective in the presence of only ten per cent blood serum. Hypochlorites and many mercurials are reduced considerably in efficacy in the presence of organic matter.

Throat gargles are a popular commercial product, yet an ideally successful germicidal mouthwash has probably never been produced. This is a field for productive research. Innumerable crypts exist in the mouth and throat into which the wash probably never penetrates. Membranes are sensitive and easily injured by harsh compounds. Saliva, bits of food between the teeth, and other organic matter combine with the gargle, increasing its volume and thus reducing the concentration of the active principle. But what about the time allowed for the gargle to act upon the bacteria? The average person usually takes less than 20 seconds for the act of gargling. In order to destroy most of the bacteria under the conditions existing in the mouth in the short space of a few seconds, a very powerful germicide would be necessary. How much less effective are the pleasant-tasting, fragrant "antiseptics" which are so highly advertised!

It was pointed out in the foregoing paragraphs that high dilutions of some dyes and chemical substances may prevent certain bacteria from growing. Specificity of germicidal action may also become a factor of considerable importance, and the possession of especially high potency toward certain organisms may result in the use of the substance for specific purposes. For example, some agents have particular value as fungicides, as for the treatment of athlete's foot. Some unsaturated soaps, as, for example, sodium oleate, linolate, linolenate, and chipanadonate, have demonstrated specific action towards pneumococci. Silver nitrate (one per cent) is used as a prophylactic agent in the eyes of new-born infants to prevent gonorrheal blindness. On the other hand, a substance possessing marked specificity of action may fail to be of service as a general disinfectant, on account of the fact that its efficacy toward some pathogens may be of very low order.

Some good germicides have been prepared by combining two different chemical agents — one demonstrating high potency principally toward Gram-positive organisms and the other showing high potency toward Gram-negative organisms. One such combination is mercresin — a compound containing o-hydroxyphenylmercuric chloride and secondary amyltricresols.

Microörganisms frequently (*Continued on page 288*)

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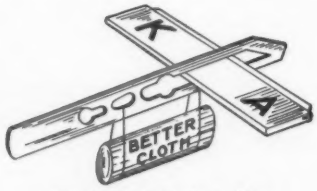

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THERE ARE GOOD GERMICIDES

(Continued from page 287)

vary considerably in their resistance to chemical substances. Bacterial spores are oftentimes extremely resistant to chemical agents; yet it is necessary in disinfection to destroy the spores as well as the vegetative forms of microörganisms. Five per cent phenol does not destroy the spores of Bacillus subtilis in 25 hours at 37 degrees C. Some of the popular market antiseptics likewise have very little effect on bacterial spores. One highly advertised and popular antiseptic did not destroy B. subtilis in one day. How can one expect wonders of such products, when oftentimes they are permitted contact with the body for only a few seconds!

In view of the wide variations in the resistances of microörganisms, the futility of rating the value of a disinfectant on the basis of one measurement, where only one organism, one temperature, and no added organic matter is used, is apparent.

The use of the proper vehicle for a germicidal substance is of great importance, for a vehicle may either enhance, reduce, or have no effect on the germicidal value of the agent. The selection of the vehicle is a matter which requires careful study — *p*H, solubility, surface tension, and toxicity are some of the factors to be considered in this choice.

Though a substance may demonstrate remarkable results in the test tube, if it lacks the ability to penetrate matter or reach the desired site, it has no value as a germicide. The physician may wish to know whether some particular agent will penetrate oil, or grease, or dried blood. The man in industry may wish information concerning the application of a substance in connection with foods or beverages. The research man must determine these facts if they are not already known.

While not a problem of large magnitude, the question of stimulated growth is one which should be adequately considered in the use of any agent in, or on the surface of, the body. A germicide may be used in such small dilution that, instead of destroying bacteria, it may actually stimulate their growth. Although it has been known for years that minute amounts of poison may act as cell stimulants, the possible application of the Arndt-Schulz law to disinfection has not been considered seriously until quite recently. One objection to present-day methods of evaluating germicidal substances is that the conditions simulated are not identical with those associated with the animal body. Although this objection is based on reason, there are sufficient yardsticks to measure satisfactorily the efficacy of a substance. No one method is sufficient in itself and there are many ways in which improvements may be made in those already existing. One of the recently suggested methods for evaluating a germicide or anti- (*Concluded on page 290*)

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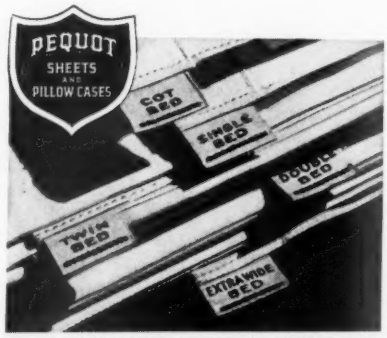

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THERE ARE GOOD GERMICIDES

(*Concluded from page 288*)

septic depends upon ascertaining the effect of the substance on living embryonic tissue — toxicity as well as germicidal action being estimated.

Contrary to some prevalent ideas, there is still much to be done in the field of disinfection. There is need, first of all, for highly skilled men, who have had a basic training in biology and chemistry with special emphasis on microbiology, organic chemistry, biochemistry, and histology. Even closer contact of members of the medical profession with the manufacturer and the research man would be beneficial where the agent is designed for medical uses. Methods of evaluation could be improved, new methods developed. The production of new substances with high germicidal efficacy, combining healing properties with extremely low or negligible toxicity, is always to be sought. Control of advertising is urgent to protect the public. The radio could also be used to a greater extent in educating the public on the subject.

Chemotherapy is a field of science closely related to chemical disinfection. By chemotherapy [see the article by Tenney L. Davis on page 273] is meant the treatment of disease by chemical compounds that have a marked degree of specificity and selective action toward the microörganisms causing the disease but which do not injure the tissues.

Compounds several times as powerful as the well-known sulfanilamide have now been developed and have been used successfully to treat mice having streptococcic infections.

In respect to disease and infection, the human race has indeed a brighter future to face than the man of a few generations ago. Progress has not become impeded but stimulated to a high degree. Some day man may be able to prevent disease by the administration of pure chemical compounds.

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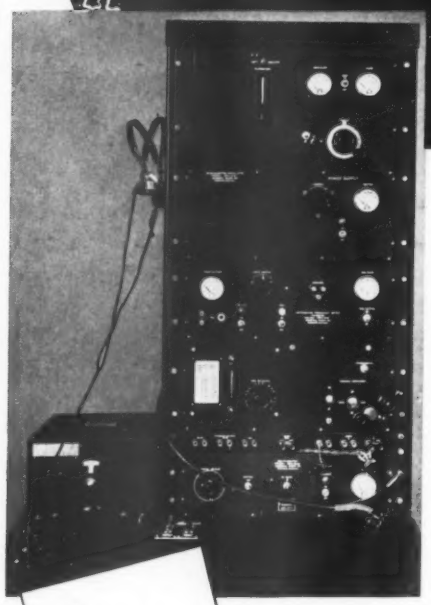

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